TERRA

THE NATURAL HISTORY
MUSEUM OF
LOS ANGELES COUNTY

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A Tyrannosaurus *brings down an* Edmontosaurus *(a type of hadrosaur) as a giant pterosaur passes overhead in the sky over eastern Wyoming.* *See page 26 for more about the North American dinosaurs of the Late Cretaceous.*

TERRA

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OF THE
NATURAL HISTORY MUSEUM
OF LOS ANGELES COUNTY

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COVER: The narwhal's tusk, which can attain over seven feet in length, is a modified tooth that erupts from the gums only in mature males. Apparently males use these tusks for display and sparring to determine breeding hierarchies. Photograph by Flip Nicklin.

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DEVELOPMENT NEWS

THANKSGIVING. This is a particularly appropriate season to offer thanks to our members, donors, and volunteers, all of whom help to strengthen our service to the southern California community. Each of you deserves special "thanksgiving" wishes from the Natural History Museum.

This year we are particularly grateful to the following friends:

The Foundations of the Milken Families for their support of exhibitions and educational programs.

The Mary Pickford Foundation, Skirball Foundation, and Whittier Foundation for their gifts in support of our education programs.

Occidental Petroleum Corporation, ARCO, and The Times Mirror Foundation, our leading corporate supporters for exhibitions and educational programs.

The Ralph M. Parsons Foundation for their continuing commitment to the Discovery Center and its new insect zoo, which is about to begin construction.

The National Science Foundation for funding our young scholars' program.

The National Endowment for the Humanities and the California Council for the Humanities for helping us bring **Nomads: Masters of the Eurasian Steppe** from the Soviet Union.

The Weiler Foundation and Shearson Lehmann Hutton for their gifts to the Times Mirror Hall of Native American Cultures.

May Company California, Mr. and Mrs. Roy Nutt, and Mr. and Mrs. Dan Pocapalia for their support of the 1989 Dinosaur Ball as Discovery Sponsors.

Ray and Nancy McCullough for taking on responsibility for the 1990 Dinosaur Ball (see below).

Charlotte and Walter Berkman, Sue Chandler, Pat House, Linda Knight, and Betty Reddin for recruiting five or more new Fellows each.

The Service Council members, who, through their on-site sales efforts, enrolled over 900 new museum members.

The Business Associates Executive Committee: James H. Cheney, Peter K. Barker, Neal H. Brockmeyer, J. Stuart Fishler, Jr., Marvin E. Garrett, William F. Hodges, John D. Jones, Michael M. Kolbenschlag, Thomas E. Larkin, Jr., Theodore M. Leary, Ronald G. Lee, Angus W. McBain, Dan McGurk, John D. Moore, Mark Myronowicz, Robert H. Nida, Stephen R. Onderdonk, Charles O. Parker, Robert T. Patterson, Keith P. Russell, and Joseph Ryan, for launching the Fall 1989 Campaign for Corporate Support.

New Fellows Robert V. Adams, Mary W. Courtright, Ronald and Jade Higgins, Councilman Nate Holden, Robert and Betty Holmes, Mr. and Mrs. Saul Kreshek, Mr. and Mrs. Robert McGrath, Nancy Lee Nichols, Deborah and William Richards, Jr., and Margaret V. Woolley.

New Business Associates Federal National Mortgage Association (Fannie Mae) Foundation, Lowe Enterprises, Inc., and Russell Group Architects.

Dr. James Clements for undertaking Bird Quest 1989 in support of the Ralph W. Schreiber Hall of Birds, sighting 2,912 species by September 1, and inspiring donors to pledge a projected $449,000 when he reaches his 4000 species goal.

DINOSAUR BALL 1990. The Dinosaur Ball returns to the Natural History Museum in 1990 with fresh new ideas and customary elegance. Nancy and Ray McCullough will chair the event, to be held on Saturday, March 10, 1990. Dinosaur Ball 1990 celebrates the Tropical Rainforest and honors Otis and Dodie Booth for their far-sighted gift to the museum's endowment fund. Highlights of the evening will include cocktails in the foyer; a special viewing of the new exhibition, **Tropical Rainforest: A Disappearing Treasure**; dinner by Roccoco in a tented enclosure, and music by Les Brown.

To be listed in the formal Dinosaur Ball invitation, Diamond Couple donations must be received by January 1, 1990. For information about the 1990 Dinosaur Ball, please call Sue Gloede at 213/744-3438.

CAPITAL CAMPAIGN: Fellows Campaign. The Fellows of the Natural History Museum have indicated a strong interest in helping the museum meet the Kresge Foundation's challenge of raising $2.34 million for our Capital Campaign by December 31, 1989. A special Fellows Fall Campaign, headed by Jamie Shoch and Pat House, has been mounted to raise funds to complete the final projects in the current $24 million Capital Campaign.

General Membership Campaign. During the fall, all members of the museum will have been given an opportunity to support the Museum's Capital Campaign to complete the Times Mirror Hall of Native American Cultures and The Ralph W. Schreiber Hall of Birds. Since annual membership contributions do not support the Museum's Capital Campaign, we ask our members to make a special gift to help reach our Capital Campaign goal of $2.34 million by December 31, 1989. Members will be contacted by phone and mail to ask for their support, which can be pledged or budgeted over a period of up to three years. Each member's donation to the Capital campaign will bring us closer to achieving our goal and secure $750,000 gift from the Kresge Foundation. Member support for this campaign will be critical to the museum's overall fundraising success.

BIRD QUEST '89. Dr. James F. Clements sighted his 2,801st

bird of the year, a Chestnut-breasted Cuckoo (*Cacomantis castaneiventris*), on August 26 in Papua New Guinea, breaking the record set by industrialist Jim Vardeman in 1983 for the number of bird species sighted in a year. Dr. Clements is helping to raise the final funding for the Ralph Schreiber Hall of Birds. He hopes to record over 4,000 species of birds by the time his year-long odyssey ends December 31.

So far, Clements has sighted birds in India, Cameroon, Ecuador, Tibet, Venezuela, Texas, and Peru. Future trips will take him to Brazil, Kenya, Thailand, Malaysia, Costa Rica, and Mexico.

NEW ACQUISITIONS

A COLLECTION OF FORTY-SEVEN CONTEMPORARY HOPI KACHINAS was recently donated to the Museum by Mrs. Lillian Stein in memory of her husband, Dr. Justin J. Stein. Once again the museum benefits greatly by the generosity of the Steins who over the last twenty-five years have contributed several hundred very fine ethnographic and historical objects to the museum's permanent collection. The recent donation of kachinas, carved for the most part in the 1980s, is significant both artistically and scientifically: the tremendous diversity of artists and styles represented provides an excellent view of recent trends in Hopi kachina carving, and thorough documentation of each piece increases the scientific value of the collection as a whole. Several of the kachinas will be displayed in the changing gallery of the Times Mirror Hall of Native American Cultures, scheduled to open in 1991.

JOHN DE LEON

The Wiharu *or White Ogre kachina, carved by Roy Fredericks, shows a composite of stylistic features: attention to the modeling of the figure as well as the addition of real materials such as buckskin, feathers and yarn. The Ogre kachinas teach that every person is dependent upon relatives and other members of the community and must contribute something in order to receive in return.*

Hopi kachina dolls are traditionally carved to represent sacred beings who act as intermediaries between the human and spirit worlds. Kachina dancers appear in ceremonies during which the needs of the people are communicated to the spirit world. People feel assured that life will continue in a positive vein and the balance of the community will be maintained. The dolls are carved by the Kachina dancers and given to children, usually girls, to instruct them in the ways of Hopi life.

Kachina carving has undergone many changes since the nineteenth century and the contrast between the early flat block figures and the finely executed kachinas of the 1980s is striking. While the origins and the essence of kachina carving remain in the sacred, and many kachinas are still carved for traditional reasons, interaction with the fine art world and appreciation by a continually growing audience has influenced carvers over the last three or four decades. The general trend has been toward refined execution and greater realism.

The incredible detail and complexity of decoration that kachina carvers of the 1960s and 1970s achieved with acrylic paints and added bits of leather, fur, cloth and yarn, continues into the present, yet new developments are apparent. Carvers of the 1980s have begun to focus more on the figure and on creating more realistic ornamentation and musculature. The recent trend is to carve all the details in wood, and many artists are experimenting with techniques such as wood burning and a greater variety of tools and materials to enable them to do this. Some carvers have also begun to experiment with wood stains and oil paints to achieve more muted, and more realistic, tones. The Stein collection represents an excellent sample of these current developments in Hopi kachina carving.

FORMER DIRECTOR MAKES MAJOR DONATION. Dr. Giles W. Mead, Director of the Natural History Museum from 1970 to 1978, recently donated 48 specimens, which he originally placed on loan to the museum during his tenure as director or shortly thereafter. Three dozen of the specimens are native gold including an exceptional arborescent specimen (see photo) from the Colorado Quartz mine near Mariposa, California. Among the other important pieces are a gem-quality trapiche emerald crystal, a large Australian opal "pineapple" (white opal replacing the mineral ikaite), a fine Brazilian indicolite tourmaline gem, and a beautiful Australian black opal. Dr. Mead played a leading role in the development of the museum's Hall of Gems and Minerals and many of the specimens which he has just given have been displayed in the hall since its opening in 1978.

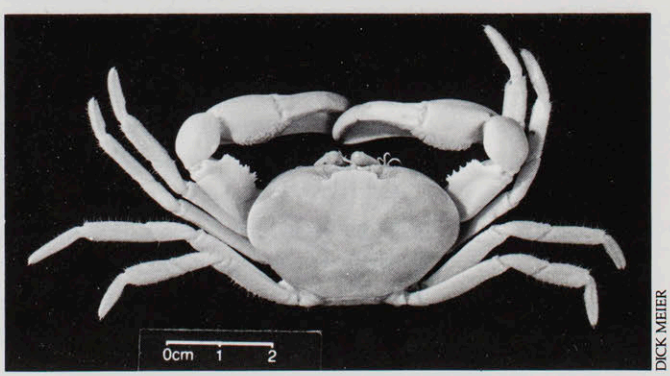
LARRY REYNOLDS

An exceptional specimen of native gold.

RESEARCH NEWS

DR. JOEL W. MARTIN (Crustacea) received a Smithsonian Short Term Visitor Award that allowed him to study deep-sea crabs at the National Museum for one week in July. He also completed a study with Dr. Robert Hessler of the Scripps Institution of Oceanography on a new genus and species of crab from hydrothermal vents in the western Pacific. That crab, collected at a depth of nearly 4,000 meters, is the first eyeless crab known to science.

An eyeless crab collected at nearly 4,000 meters in the western Pacific.



DICK MEIER

COLLECTION OF NATURAL HISTORY MUSEUM OF LOS ANGELES COUNTY

Fiesta Scene *(c. 1890) by Alexander Francis Harmer is an idealized version of rancho life in California.*

California's Ranchos
An Enduring Legacy

by IRIS H. W. ENGSTRAND

In California today—as new developments with such historic names as Rancho Peñasquitos, Rancho Jamul, Mission Viejo, and Laguna Niguel dot the landscape with homes and shopping centers—the heritage of the ranchos is a popular theme for residents and real estate promoters alike. Nevertheless, as the colorful aspects of rancho life continue to grace advertising brochures and "the days of the dons" provide nostalgia for barbecues and dances, the complicated and often difficult times faced by the earliest settlers recede further into obscurity. Newcomers to the state marvel at the abundance of Hispanic names along busy freeways, but can only imagine the tranquil days when there were cattle instead of condominiums on a thousand hills.

Those even slightly acquainted with California's past know that rancho life has always been an integral part of the state's history, but few can appreciate the tortuous paths through legal entanglements taken by those early "dons" and the subsequent clashes created as two distinct cultures came together in a rich frontier area. The purpose of this article is to trace the history of California's Spanish and Mexican land grants and to review the controversies surrounding their confirmation during the early American period.

The First Spanish Land Grants in California

In contrast to other areas of the Spanish Southwest, the granting of land for private ranchos in California came very near the end of Spain's colonizing effort in the New World. In fact, the first land grant was not made until 1775 when a retired soldier was encouraged to take a few acres of land near Mission San Carlos (Carmel). Even then, the granting of additional ranchos proceeded slowly as soldiers who had accompanied the first expedition to Alta California in 1769 reached retirement age and Spain looked for ways to increase the productivity of its distant province. Because California lacked civilian settlers, was a long distance from central Mexico, and lacked apparent mineral wealth, no substantial land grants were made until the second decade of Spanish settlement, when Governor Pedro Fages approved three large concessions in the fall of 1784.

At the time the first permanent ranchos were granted in 1784, nine Franciscan missions, four presidios, and two civilian pueblos had been established between San Diego and San Francisco in Alta California. The number of Spaniards was just a few hundred, and the Indian population is estimated to have been somewhere between 150,000 and 250,000. The missionaries, under the leadership of Fray Junípero Serra, father president until his death on August 28, 1784, had attracted approximately 8,000 natives into the missions to learn agriculture and Christian ways. During the remainder of the Spanish period, twelve additional missions and one more civilian settlement were founded, leaving a significant expanse of territory available for grazing and cultivation. Much of the best land, however, was held by the Franciscans in trust for the Indians.

The first major land grant petitions in 1784 came from Juan José Domínguez, José María Verdugo, and Manuel Nieto, three soldiers of the San Diego Presidio, who asked for tracts in the vicinity of the recently founded pueblo of Los Angeles. Verdugo's original letter, written from his post at Mission San Gabriel, is typical:

> José María Verdugo, Corporal of the Royal Presidio of San Diego, at present stationed at the Mission of San Gabriel, with proper severance, appears before your Honor and says, that in consideration of keeping my animals...at this mission...and not having a place where my above mentioned livestock may be pastured with proper convenience, I humbly ask for the very sincere charity of your Honor in order that you may be pleased to designate a tract...about a league and a half from this Mission at the "Arroyo Hondo..."

The governor's answer, dated at San Gabriel, October 20, 1784, simply stated:

> I concede to the petitioner the permission which he solicits to keep his cattle and horses at the "Arroyo Hondo" distant a league and a half from the Mission of San Gabriel on the Monterey Road; provided that he does not prejudice the said Mission, nor the inhabitants of the Reina de los Angeles, and has someone in charge, without being exposed to the Gentile Indians, or in any manner injuring them.
>
> Pedro Fages

Although simple in nature, this early concession of land was based upon the legal heritage of Castile, as modified by the discovery of America and the opening up of new lands for colonization

List of Ranchos from North to South

RANCHO BREISGAU	8	RANCHO ARROYO DE LA ALAMEDA	41
LARKIN'S CHILDREN'S RANCHO	12	RANCHO PALA	18
ALBION	31	RANCHO SAN JUAN BAUTISTA	51
RANCHO NEMSHAS	13	RANCHO SANTA TERESA	19
NEW HELVETIA	38	RANCHO LAS ANIMAS	16
RANCHO CAÑADA DE CAPAY	9	RANCHO LLANO DE TEQUISQUITE	17
RANCHO QUESESOSI	1	RANCHO SAN ANDRÉS	43
FIVE LEAGUES ON THE SACRAMENTO RIVER	2	RANCHO AROMITAS Y AGUA CALIENTE	15
RANCHO CARNE HUMANA	54	RANCHO CARNEROS	60
RANCHO BODEGA	40	RANCHO BOLSA DE LOS ESCARPINES	62
RANCHO CABEZA DE SANTA ROSA	64	RANCHO RINCON DE LA PUNTA DEL MONTE	63
RANCHO HUICHICA	25	RANCHO GUADALUPE Y LLANITO DE LOS CORREOS	45
RANCHO LAGUNA DE SAN ANTONIO	7	RANCHO SAN VICENTE	46
RANCHO CORTE MADERA DE NOVATO	52	RANCHO POSA DE LOS OSITOS	61
RANCHO CAZADORES	11	RANCHO LOS OJITOS	53
PUNTA REYES	44	RANCHO HUERHUERO	48
RANCHO LAS GALLINAS	28	RANCHO ATASCADERO Y ASUNCIÓN	50
RANCHO LAS BAULENES	30	RANCHO CAÑADA DE LOS OSOS	47
RANCHO PINOLE	32	RANCHO PECHO Y ISLAI	49
RANCHO SAN PABLO	20	RANCHO CORRAL DE PIEDRA	55
RANCHO LAGUNA DE LOS PALOS COLORADOS	29	RANCHO HUASNA	22
YERBA BUENA	39	RANCHO BOLSA DEL CHAMISAL	57
RANCHO SAN MIGUEL	42	RANCHO TEPUSQUET	56
THOMPSON'S RANCHO	14	RANCHO TEJON	5
		RANCHO CASTEC	6
		RANCHO TEQUEPIS	58
		RANCHO SAN PEDRO	3
		RANCHO CONEJO	4
		RANCHO LAS VIRGENES	35
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Map of California showing the location of selected land grants. From California Rancho Diseños: Designs on the Land *by Robert H. Becker.*

COURTESY OF THE BOOK CLUB OF CALIFORNIA, SAN FRANCISCO

and settlement. In fact, the granting of lands in California was investigated and approved by the Attorney General of the Provincias Internas, Pedro Galindo Navarro, in a letter to Commandant General Jacobo Ugarte y Loyola on October 27, 1785. This opinion was careful to note that land concessions should respect all the safeguards provided by legislation concerning the Indies. The key passages follow:

> The designation of sites for breeding cattle solicited by some settlers of California and proposed by the Governor in his official letter of 20 November 1784, cannot and must not be made within the boundaries assigned to each Pueblo....By the laws from the 1st and continuing to the 13th, Title 12 of the same Book IV [Laws of the Indies] is permitted the distribution and designation of...sites for ranches of cattle and sheep, provided however that they be given far from the Indian pueblos and their cultivated fields....

The pueblo residents, who were also involved in raising cattle and growing crops, were also to

be protected from injury. Governor Fages was further instructed that he grant lands

> at such a distance that no injury can result to the mission, pueblos and rancherias of Indians, nor to their planting ground, that he make grants and distribute sites for herding and breeding livestock, under the express condition that the residents and settlers, to whom such are granted, be obliged to furnish as many herdsmen and guards as may be sufficient to prevent injury and indemnify the amount of such which by chance may be caused, and further that no resident or settler shall have more than three sites or grants, being under the obligation of constructing a stone house on each one, of having at least two thousand head of cattle thereon, and that notwithstanding its grant and concession, the pastures remain to be enjoyed in common, and that in places where there are no herding grounds for stock, sites may be given for industry and other cultivation....
>
> Chihuahua, 27 October 1785, Galindo Navarro

Rancho San Rafael of José María Verdugo included 36,403 acres adjacent to the northern border of the town of Los Angeles. It included a major portion of the present-day cities of Glendale, Eagle Rock, and Burbank. The other two grants made in 1784 were Rancho San Pedro, over 75,000 acres in the area of San Pedro, Palos Verdes, Dominguez Hills, and Carson, assigned to Juan José Dominguez, and an immense 158,000-acre tract known as Rancho Los Nietos granted to Manuel Nieto. The latter rancho, some thirty-three square leagues (one square league equals 2.6 miles square and contains 4,438 acres) extending over a large portion of today's Los Angeles and Orange Counties, was divided among Nieto's heirs in 1804. It was regranted in 1834 by the Mexican government as the five separate ranchos of Los Alamitos, Los Cerritos, Las Bolsas, Los Coyotes, and Santa Gertrudis. These included much valuable land in Long Beach and adjacent areas to the south along the coastal plain.

One grant was recorded in 1785, and then no further concessions were made until 1795 when Governor Diego Borica rewarded a number of retiring soldiers with the granting of ten ranchos during that year. Among the best known were

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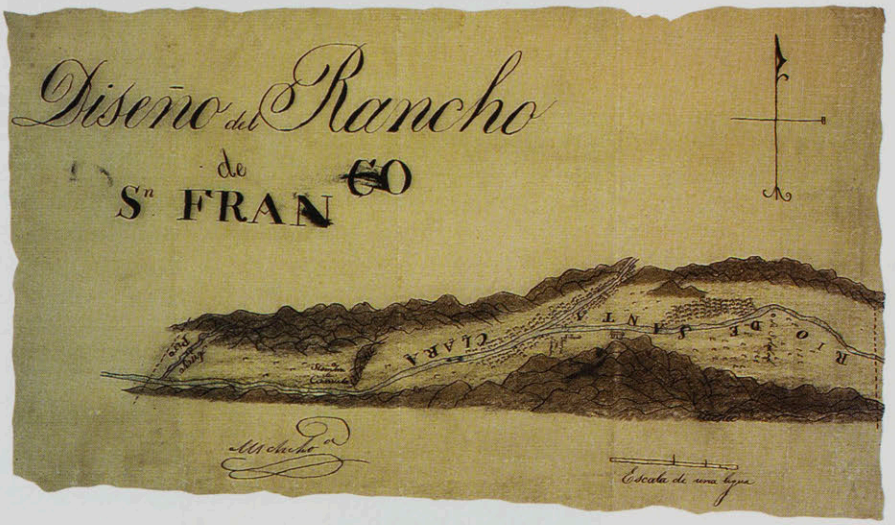


Diseño (map) of Rancho San Francisco. Diseños were submitted by colonists to the Spanish or Mexican authorities to provide proof of occupation.

Rancho del Refugio, six leagues at Gaviota in Santa Barbara County granted to José Francisco Ortega, and Rancho Simí, fourteen leagues in Ventura and Los Angeles Counties granted to Francisco Javier, Miguel, and Patricio Pico.

Because the Franciscan missions controlled vast acres of choice agricultural land extending from San Diego to north of San Francisco Bay, there was considerable encouragement by the military governors for secularization of these establishments. Even though the missions were, according to the Laws of the Indies, to become secular towns with parish churches in ten years after their founding, the friars in Alta California did not believe the Indians would be sufficiently ready for an independent existence in that length of time. Not only did the Franciscans protect the land for the Indians, they opposed the granting of land to individuals. Father José Señan, a future father president, reported to the Viceroy in 1796:

> I therefore believe that under no circumstances should retired soldiers or others with special credentials who wish to settle in the Province be permitted to establish themselves separately in remote areas or in villages outside the towns.... The consequences to be expected from scattered and isolated colonization are distressing to contemplate. Colonists thus openly exposed are likely to suffer mischief at the hands of gentiles [nomadic Indians]....In short, they will live in these remote regions without King to rule or Pope to excommunicate them.

Even though the Spanish governors wanted to

move forward with secularization, they never succeeded in overcoming Franciscan objections. Additionally, applicants for grants were few and there remained an abundance of land; thus the matter was left unresolved for a time.

During the remainder of the Spanish period (1796 through 1821), only 21 additional grants were made. These extended from present-day Orange County northward to the San Francisco Bay area and included such valuable parcels as Rancho los Feliz, bordering the pueblo of Los Angeles, granted to Vicente Feliz in 1802; Topanga Malibu Sequit, granted to José Bartolome Tapia in 1804; Rancho Santiago de Santa Ana, granted to Antonio Yorba in 1809; and Rancho San Antonio in Alameda County, granted in 1820 to Luis Peralta.

Mexican Land Grants

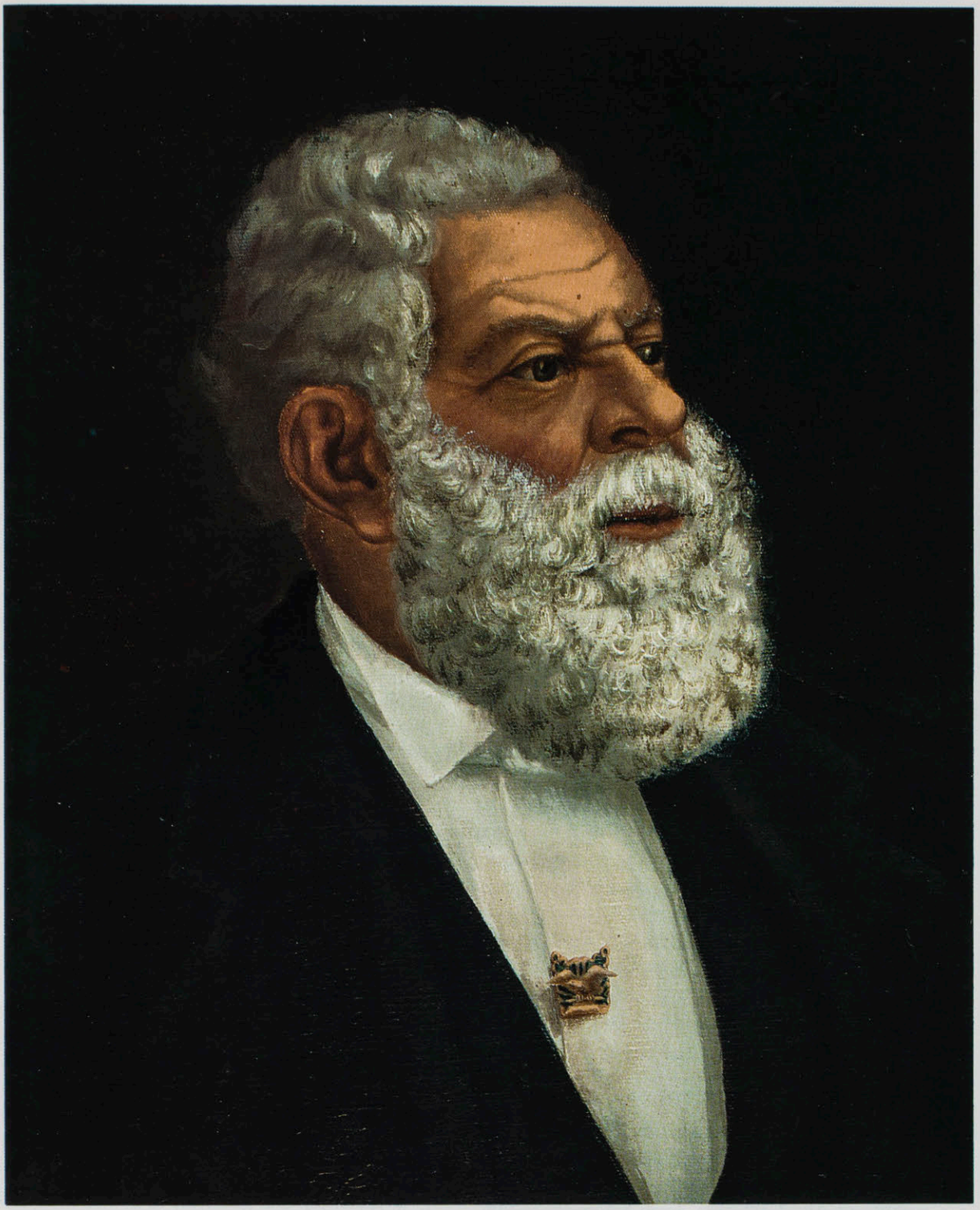
After Mexico's successful bid for independence in 1821, local government officials proceeded in much the same fashion as their Spanish predecessors. Under native-born Luis Arguëllo, the first governor during the Mexican period, about seventeen ranchos were granted, reaching as far south as San Diego and extending to the north of San Francisco Bay. With the adoption of a federal constitution in 1824, more liberal policies were designed to promote the settlement of frontier areas. Mexico's colonization law of August 18, 1824 provided in Article 2 that "The objects of this law are those national lands that are neither private property nor belonging to any corporation or pueblo and can therefore be colonized." In order to attract colonists, this law not only made it possible, but encouraged foreigners to establish themselves in Mexican territory. The law also promised security of both person and property of landholders, as well as freedom from taxes for four years. Any Mexican of good character, or any foreigner willing to become a permanent resident of Mexico, could petition for up to one square league of irrigable land, four of nonirrigable land, and six of grazing land–a total of eleven square leagues.

The next decree of November 21, 1828 authorized the governors to grant vacant lands to *empresarios*, families, or private persons, whether Mexican or foreign, who solicited them for habitation and cultivation. The conditions to be met were essentially the same as during the Spanish period and involved a petition, description, *diseño*, and proof of occupation. Each new colonist, after having cultivated or occupied the land, was ordered to prove the same before the municipal authority so that the necessary record could be made and forwarded in a quarterly report to the supreme government. Between 1825 and 1831, Governor José María Echeandía granted only about twenty ranchos, including the historic tar pit area at La Brea to José Antonio Rocha in 1828.

From the beginning of the Mexican period, residents of California and other provinces newly freed from Spanish control looked toward the acquisition of good land suitable for cultivation and grazing. In its overall colonization program, the Mexican Junta envisioned partial Indian emancipation, secularization, and distribution of lands held by missionary orders. Pursuant to these plans, and because of his personal opposition to the mission system, Governor Echeandía signed a decree in 1826 providing for freedom of Indians who had been Christians for fifteen years, or since birth. This decree achieved little success because many of the Indians, unprepared for a self-supporting independent existence, chose not to leave the mission. Echeandía's subsequent secularization plan of January 6, 1831 was suspended by his successor Manuel Victoria.

The Secularization of the California Missions

In response to mounting pressure by residents, the Mexican Congress finally ordered secularization of the California missions on August 17, 1833. A year later, California Governor José Figueroa issued rules that forced the removal of the Franciscans from their missionary posts and indicated how the land was to be divided up. The missions were to be converted into civilian pueblos and the head of each Indian family was to receive land neither less than 100 varas nor more than 400 varas square together with livestock, tools, and seeds (there were 32.99206 inches to a *vara*). The village thus created was also to receive sufficient common lands for pasture and other uses. Even though Indians were to be granted up to one-half of the mission lands, and did in fact receive certain land grants, much of the land was parceled out to non-Indians. During the ten-year period from 1835 to 1845, nearly 700 land concessions, many of which included the most fertile ex-mission tracts, were made to private claimants. Often close friends or supporters of the governor received the choice areas. Former



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A portrait of Pío Pico, artist unknown, painted c. 1880. Pico served as California's governor from February 1845 to August 1846 and made the last grants of what had once been lands belonging to Mission San Luis Rey.

lands of Mission San Luis Rey in present-day northern San Diego County provide a typical example of land distribution during this period.

In 1836, the 17,634-acre Rancho Valle de San José, which later became a part of Warner's Ranch, was granted to Silvestre de la Portilla. In 1840, José Antonio Pico, brother of Pío Pico, received an adjacent 26,688 acres of former mission lands (Rancho San José del Valle) from Governor Juan Bautista Alvarado. Also in 1840, Governor Alvarado further divided the mission lands and granted the 8,877-acre Los Vallecitos de San Marcos Rancho to José María Alvarado. By far the largest parcel carved from San Luis Rey was the 89,642-acre Rancho Santa Margarita granted by Alvarado to Pío and Andres Pico, and to which was added an additional grant of Las Flores in 1844. These two grants eventually totaled 133,440 acres and today contain the United States Marine Base of Camp Pendleton. In his last year as governor, Alvarado granted the 13,311-acre coastal tract of Agua Hedionda to Juan María Marrón; Governor Micheltorena in 1844 granted José Antonio Serrano the 13,309-acre Pauma Rancho and the Las Flores tract to the Picos.

Pío Pico served as California's governor from

February 1845 to August 1846 and made the last of the grants of San Luis Rey lands: 2,233 acres of Rancho Temecula to an Indian, Pablo Apis; 2,219 acres of Rancho Guajome to Indian brothers Andres and José Manuel; 1,184 acres of Buena Vista to an Indian, Felipe Subria; and the 13,322-acre Rancho Monserrate to Isidro María Alvarado. Some of the grantees, especially the former mission Indians, relinquished their titles within several years, although Pío Pico, Juan Marrón, and Isidro Alvarado managed to hold their ranchos well into the American period.

The San Fernando Valley in Los Angeles County provides another example of granting activity after secularization. Altogether six ranchos, including the 116,858-acre ex-Mission de San Fernando patented to Eulogio de Celis, were granted to private owners between 1840 and 1845. The other five were Rancho Tujunga, 6,600 acres patented to David W. Alexander, Francis Mellus, Agustin Olvera, and the heirs of Francisco López; El Escorpion, 1,109 acres patented to Indians Urbano, Odon, and Manuel, and Joaquin Romero; El Encino, 4,460 acres patented to Vicente de la Osa, Aguila (widow) and Francisco (minor son), legal heirs of the Indian Roque, deceased, and Rita, minor daughter and only legal heir of the Indian Francisco; Rancho Providencia, 4,064 acres to David W. Alexander and Francis Mellus; and Rancho Cahuenga, 388.34 acres also to Alexander and Mellus. Several former mission Indians received land but did not hold on to it for long.

American Settlement of California

The American conquest in 1846 and subsequent discovery of gold in 1848 forever altered the pattern of settlement in the once-isolated province of Alta California. Even before these two events, many Americans and other foreigners had found their way to Mexican California's peaceful shores and had carved out substantial land holdings. Because the tremendous herds of cattle provided hides for the leather industry and shoe manufacturers in New England and tallow for the soap makers in both Americas, petitioners could be found among settlers, traders, and adventurers of all countries. Those arriving between 1830 and 1840, for the most part, had been single men on board with the hide and tallow traders or mountain men following the overland trails in search of wealth and property. Many had married local Hispanic women and had participated in Mexico's generous colonization program. Those arriving after 1841 were generally family men with wives and children who made up the wagon trains of the mid-1840s. Some of these also obtained land grants, especially in northern California, and others were a part of the resistance known as the Bear Flag Revolt of June 1846.

With the American takeover and signing of the Treaty of Guadalupe Hidalgo on February 2, 1848, California's military governor, Richard B. Mason, felt bound to fulfill the obligations of the United States to Mexican landowners. Governor Mason also believed it prudent to assign Captain Henry W. Halleck, Secretary of State for the territory of California, to investigate and "report on the [Mexican] laws and regulations which govern the granting or selling of public lands in California" and to consider those "respecting the lands and other property belonging to the missions...." Halleck's report of 1 March 1849 concluded:

> a large number of land titles in California are very indefinite with respect to boundaries, the grants being for so many "sitios," creaderos, etc. lying between certain hills, streams, etc. as shown by rough sketches attached to the petitions. These sketches frequently contain double the amount of land included in the grants, and even now very few of these grants have been surveyed or their boundaries definitely fixed.

Halleck, custodian of the Mexican archives in Monterey, also expressed concern about the legality of many of the grants because the requirements of Spanish and Mexican law had not been followed.

To assist the U.S. government in analyzing the land grant situation in California, President Zachary Taylor sent William Carey Jones, son-in-law of Senator Thomas Hart Benton, to investigate the condition of titles in California and make an independent recommendation. Jones had been a practicing lawyer in Louisiana and had gained a good knowledge of Spanish legal documents. As a result of his lengthy study, Jones concluded:

> The grants in California, I am bound to say are most *perfect titles*, that is, the holders possess their property by titles, that, under the law which created them, were equivalent to patents from our government; and those

which are not perfect–that is, which lack some formality, or some evidence of completeness–have the same *equity* as those which are perfect, and were and would have been equally respected under the government which has passed away.... I think the state of land titles in that country will allow the public lands to be ascertained and the private lands set apart, by judicious measures, with little difficulty. Any measure calculated to discredit, or cause to be distrusted, the general character of the titles there... would, I believe, also retard the substantial improvement of the country: a title discredited is not destroyed, but every one is afraid to touch it, or at all events, to invest labor and money in improvements that rest on a suspected tenure....

Jones believed that the U.S. government and its people would be best served by a speedy confirmation of rancho grants and other land titles.

Halleck, also an able linguist familiar with both Spanish and French, had grave doubts about the legality of certain grants. Although several modern textbooks feel that Jones had the more "humane" position with regard to Mexican claimants, it is important to note that Jones's brother-in-law, John C. Fremont, was the beneficiary of a rich claim to Las Mariposas grant, one of the few on which gold had been discovered, and that Jones himself had acquired a claim to twelve leagues of San Luis Rey and Pala mission lands. When Congress was not persuaded by his recommendation for speedy acceptance of land grant claims, Jones became a leading lawyer on behalf of claimants both in the San Francisco District Court and in the Supreme Court in Washington, D.C. Henry Halleck and his law firm of Halleck, Peachy & Billings also became active in seeking confirmation of land claims.

Through the recommendation of Halleck and William Gwin, U.S. Senator from California (and rival of John Fremont), Congress passed the California Land Act of 1851. The Act placed full authority for adjudication of land claims in the courts and "marked a major step forward" by eliminating Congress from the procedure. A Claims Commission of three members appointed by the president was to hear testimony and to study the documents presented by claimants. The commission could either confirm or reject the claims and either side could appeal to the District Court, but the process was fraught with delay.

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Los Feliz Ranch House, Griffith Park area, Los Angeles, c. 1900. Rancho Los Feliz was one of the last of the Spanish land grants in California; it was awarded to Vicente Feliz in 1802.

Part of the delay in confirming land claims was the lack of documents in possession of the claimants, vaguely defined boundaries, a lack of improvements on the land to indicate compliance with Mexican law, and some fraudulent claims. The many newcomers to the state during the post-gold rush days were unsympathetic to large land holdings and often settled on portions of grants, claiming they did not know they were on private property. Squatters' rights further confused the issue. Other problems stemmed from the necessity of hiring costly lawyers; the different laws, customs, and languages faced by Hispanic claimants; the cost of transportation to San Francisco; and the long time necessary to receive a final patent. Confirmation of the Simi grant, the first in Ventura County, took fourteen years, or until 1865, to be patented. Even though the Land Commission has been characterized as moving very slowly, it considered 813 claims in five years. Of these, 603 claims were confirmed, 190 rejected, and the rest withdrawn. Even though 209 claims were not appealed by either side, the appeals process for the others placed an additional burden of time and money on the claimants.

Arguments for and against the process for confirming land claims in California abound. For an accurate appraisal of the work of the Claims Commission, one must look at the merits of each case. Several excellent books and numerous articles have been written about individual ranchos and their grantees in California. Many others

Mission of San Carlos Borromeo de Carmelo *(Carmel) was painted by Edwin Deakin sometime between 1878 and 1897. The first California land grant was made in 1775 when a retired soldier was encouraged to take a few acres of land near this mission.*

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with abundant manuscript sources await publication. A typical example among recent contributions is the story of Rancho Jesús María in Santa Barbara County by Lois Roberts. A grant made to three members of the Olivera family in 1837 and sold to Lewis T. Burton, an American, is traced through the Claims Commission and brought up to modern times.

An interesting sidelight to the usual discussion is Geoffrey Mawn's exception to a statement by William Carey Jones that there were no "regular surveys made of grants in California..." and that "[T]here was no public or authorized surveyor in the country." Mawn's article on Jasper O'Farrell covers the career of this professional who surveyed and mapped at least twenty-one Mexican land grants in both southern and northern California between January 1844 and May 1846. O'Farrell's *diseños* of Timothy Murphy's Rancho Punta de San Pedro and Pío and Andres Pico's Rancho Santa Margarita y las Flores show that he was not only a competent surveyor, but also a skilled draftsman.

If the 1850s were difficult for rancho claimants because of rigid land-title examinations, litigation costs, and interminable appeals, the 1860s brought new troubles in the form of grasshoppers, cattle disease, floods, and, finally, a severe drought. These, plus oppressive property taxes, made it difficult, if not impossible, for the California dons to maintain their large estates. Some of the more remote ranchos, and those of a few farsighted families, remained intact through the years, but many of the original claimants sold out to new arrivals such as Lewellyn and Jotham Bixby and their partner James Irvine. Even so, these large landholdings, one of the most enduring legacies inherited from Spain and Mexico, "remained," according to historian Robert Glass Cleland, "the controlling factor in much of the state's settlement and agricultural development for nearly half a century."

Although times have changed and California life seems to have given way to a frantic pace, the heritage of the ranchos lives on in memory. The romantic image of hard-riding vaqueros branding their calves on the unfenced range is a part of the state's history and allows many owners of ranch-style homes nestled in the Simi Valley or gracing the beachfront at Malibu to think in terms of this colorful past. As more individual stories are written, these, too, will enhance the understanding of California's earliest pioneers.

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THE TOPHET AND "SACRIFICE" AT PHOENICIAN CARTHAGE

An Osteologist's Perspective

by JEFFREY H. SCHWARTZ

Photographs by the Author

During the latter half of the 1970s, UNESCO sponsored Save Carthage, a multinational archaeological effort to recover and analyze as much as possible of the preserved history of the ancient city of Carthage, which lies on the Mediterranean coast of what is today Tunisia. Archaeological teams from England, Italy, Denmark, Sweden, Holland, France, Germany, Canada, and the United States, under the auspices of the Tunisian government and Department of Antiquities, descended on the site and excavated for four, five, and if possible, six years of field seasons in a massive attempt to unravel some of the mysteries of the Roman empire's most famous rival.

Carthage is best known as the city of Queen Dido and of Hannibal and his army of elephants. According to the ancient historian Timaeus, Carthage was founded by Queen Dido in 814 B.C.E. (before the common era). The oldest archaeological evidence so far known dates, however, to 750 B.C.E. The first settlement by Queen Dido and her followers, in what was the land of the Berbers, was supposed to have been on Byrsa hill, which overlooks the Mediterranean coastline. Legend has it that the Berbers told Queen Dido that she could have the land that could be covered by an oxhide. The ingenious Queen Dido is said to have cut the hide into strips and surrounded the elevation of the Byrsa (which, in Greek, means "oxhide") with them.

The Carthaginians carried on the tradition of trading and seafaring characteristic of their Phoenician ancestors of the eastern Mediterranean. And, also like their forebears, the Carthaginians tried, usually with success, to expand their influence and holdings throughout the Mediterranean. Such actions of power and expansionism put Carthage in direct opposition to the Roman Empire, as a result of which the two entered into what would be the first of the three Punic Wars it would take Rome to overpower Carthage once and for all. (The term "Punic" comes from the Latin *Punicus*, referring to Phoenicians of the western Mediterranean region.) The first Punic War lasted from 264 to 241 B.C.E. and was brought to a close with a Roman naval victory off the coast of Sicily. It was during the second Punic War (218 to 202 B.C.E.) that Hannibal left his mark on history by leading an army of men and elephants from southern Spain into what is now France, across the Alps, and into the heartland of Roman territory. There, Hannibal defeated the Romans in a series of battles during 217 to 216 B.C.E. and returned to Carthage victorious. Unfortunately for the Carthaginians, the Roman army, led by a young Scipio Africanus, retaliated. They defeated Carthaginian forces in Spain and pressed on into northern Africa, bringing the second Punic War to an end with a victory at the plains of Zama, which lay at the back door of Carthage. Years later, Scipio Aemilianus razed Carthage to the ground to conclude the third Punic War (149 to 146 B.C.E.).

After the defeat of Punic Carthage, the Romans had little interest in colonizing the region, although there was an abortive attempt by Tiberius Caesar Gracchus in 122 B.C.E. Almost eighty years passed before Julius Caesar again proposed recolonizing Carthage, but it was not until the reign of Augustus that recolonization began in earnest, in 29 B.C.E. Eventually, Roman Carthage outdid the glory of Rome, reaching heights of prosperity during the late fourth and early fifth centuries A.D. Roman Carthage fell on October 19, 439, in a bloody takeover by the invading Vandals, who, in 533, were easily conquered by the Byzantine general Belisarius acting under orders from Emperor Justinian. In turn, the Islamic dynasties were in force from 698 to 1574, the Turks from 1574 to 1881, and the French from 1881 until the founding of the Republic of Tunisia in 1957.

Ancient History Is Written by the Victors

The history of Punic Carthage has come to us largely from Greek authors and not from the Carthaginians themselves. Somewhat similar to the loss of knowledge with the destruction of the ancient library at Alexandria, Carthaginian history as known to Punic Carthaginians died with the death of the city at Roman hands. Thus, those archaeological teams whose allocated excavation areas included the remains of Punic levels of occupation were truly excavating in an unknown realm. The reason I say this is because it is always unclear just how much of recorded ancient history is real and how much is an elaboration to glorify the victorious and vilify the opposition.

For instance, the Greek historian Appian, who lived during the second century A.D., derived the "facts" for his often cited work *Libyca* in part from the second-century B.C.E. Greek author Polybius. In Appian's recounting of the ultimate Roman victory, the Roman forces broke into the Carthaginian harbors, destroyed everything architectural and, from there, plundered and burned the city to the ground. As described by Appian, and confirmed during the Save Carthage project, the Carthaginian harbors consisted of a rectangular mercantile harbor and a circular military or naval harbor. The recent excavations of the harbor system indicate that approx-

Left: This view of Carthage's Tophet, or infant burial ground, shows two types of grave markers used: a thin limestone stela in the foreground, and the chunkier sandstone cippi. Part of an inscription is preserved on the stela. The two cippi on the left are adorned with bas relief carvings: the cippus on the far left bears a representation of the god Tanit and the cippus next to it an image of a stela.

imately 120,000 square meters of earth were removed to make the 150 by 400 by 2 meter rectangular harbor, and at least 115,000 square meters of earth were removed to make the circular harbor, which was perhaps 275 meters in diameter. Ships reached the circular harbor only by way of the rectangular harbor, which alone had access to the Mediterranean. With the harbors in a position to protect the sea side, according to Appian, a massive wall with three lines of defense surrounded the rest of the city. Within the lines of defense were rooms that held hundreds upon hundreds of military horses and elephants.

Surely, one would think, given the devastation that the Romans brought to bear upon Carthage, archaeologists would find traces of these buildings and their inhabitants. For, after all, the ruins left by the Roman army of the tenements that were built upon the slopes of Byrsa hill have been discovered. However, neither the presence of animal garrisons around the rectangular harbor nor the existence there of either horse or elephant have yet been demonstrated archaeologically. During the years that I was in charge of analyzing all bone material recovered from the excavation around the mercantile harbor, skeletal remains of these animals never came to light. Furthermore, no bony trace of elephant, from any of the Punic levels of occupation, has so far been identified by me or any other osteologist working on the material from Carthage. The Punic harbors, as popularized by Appian, may have been turned upside down by the Romans, but the rest of the story remains to be confirmed.

During our excavations we discovered that, well before the grand harbor system was built—at least two centuries earlier, if not at the very beginning of Carthage—a channel had been dug that coursed from the ancient villaed section of Carthage across parts of what would become the military and mercantile harbors and docks. It is probably more likely that horse- or oxen-towed barges, rather than boats, were used to move objects along the channel. The channel went straight to another area of Punic Carthage, called the Tophet, which may have been set off from the rest of the city by a stout wall. Here in the Tophet, over the years, archaeologists have uncovered small urns in which were usually interred the burned bones of human infants. Occasionally, there would be the burned bones of animals. Often there would be amulets in the urns with the human bones. The most common amulet, called an udjat (pronounced "ooze-at"), was a representation of the eye of the Egyptian god Horus and was used by the Carthaginians as a symbol to ward off the evil eye. Sometimes, although less frequently, fine glass beads or beads of semiprecious stones, small ivory carvings of human or animal figures, or even items made of silver or gold were put in an urn with the amulets.

Grave markers or headstones identified sites where some urns were interred. There were thin, obelisklike stone markers (called *stelae)* and chunkier headstones (called *cippi* [pronounced "chippy"], singular *cippus).* Cippi were carved from sandstone and were associated with the earlier phases of urns. The earliest cippi were L-shaped and could be associated with an urn containing either human or animal remains, while the later ones were larger and more square and apparently only erected above urns containing the remains of humans. Stelae were made from limestone and replaced the square cippi in yet later phases of urn burials. Sometimes a stela or a cippus might be carved in low relief or etched on one surface. Less fre-

A carving on a cippus shows the gods Ba'al Hammon (the crescent and sphere above) and Tanit (the stylized figure below).

quently, we found written inscriptions on a stela or cippus. A common engraving, however, was an image of a burial urn itself. But there were also the iconographic representations of the two major Carthaginian gods: Ba'al Hammon and Tanit.

Tanit (pronounced "tah-neet") seemed to symbolize "mother earth." She was usually depicted as having a broad-based triangular body from the upper, narrow region of which extended on either side two short "arms" and on top of which sat a round "head." During one of the excavation seasons I was at Carthage, I discovered in one of the burial urns a small, gold amulet or, perhaps more accurately, a charm in the shape of Tanit. The base and arms were a solid but thin piece of gold, while the head was a ring of gold wire, through which one could thread a string or a encircle link of a necklace or bracelet. One usually found a representation of the entire outline of Tanit on the stelae and cippi. Perhaps she had sticklike arms or, like the charm I found, an "open" head, but she was always recognizable.

Ba'al Hammon was the male god. He was the god of the sun and heavens, and of fire. His engraved image on the gravemarkers was that of a crescent lying over a sphere with a spot in the center, looking very much like an eye and its upper lid floating in space. When the two gods were depicted together, Ba'al Hammon was placed above Tanit. The "floating eye" might at other times be associated with an image of a burial urn cut into the grave marker in bas relief.

What was the significance of the Tophet, with its urns filled with the burned bones of human infants and sometimes those of animals? With amulets, beads, and other items placed in some urns? With grave markers? And with images of the gods Ba'al Hammon and Tanit? The most common story passed down through history is that the Tophet, the burned bones of infants, the urns, the beads and amulets, and the grave markers with images of gods were associated with a gruesome ritual practiced by the Carthaginians, the ritual of child sacrifice.

Infant Sacrifice or Infant Burial?

Although there is a general agreement among the surviving travelers' stories that the Carthaginians practiced child sacrifice, one does not know for certain what the impetus for sacrifice actually was. There is a stela housed in the Bardo Museum in Tunis that depicts a man, apparently a priest, holding an infant. The preserved inscriptions, written in Phoenician, refer to an offering. A logical conclusion would be that a religious offering—any religious offering—would be made to a god (or even two gods). Ba'al Hammon and Tanit present themselves as likely candidates in this regard and inscriptions on some stelae have been interpreted as specifying these two gods as the foci of such offerings. The third-century B.C.E. Greek author Kleitarchos is cited as describing the Phoenicians, including the Carthaginians, as burning children to the male god Kronos, who was the Greek version of Ba'al Hammon. The Tophet was also sometimes referred to as the "Precinct of Tanit." The reasons for the human offerings are, however, unclear. There are a few possibilities: to thank or repay the god or gods for a good or beneficent act, to ask for a favor, or to implore the god or gods not to reinflict a calamitous event, such as a plague, drought, illness, premature death of a family member, or a loss in battle.

The specific details of the Carthaginian rite of child sacrifice are sometimes in conflict. According to Kleitarchos the infant offering was placed in the outstretched hands of a bronze statue of the god Kronos (i.e., Ba'al Hammon) beneath which the sacrificial fire blazed. The first-century B.C.E. Greek author Diodorus Siculus wrote that the sacrificial infants were placed into the hands of such a bronze statue and then fell into the flames. Kleitarchos' description of the small body in the flames gave rise to the image of the "sardonic smile and laughter": the effects of the intense heat would, among other things, shrink the flesh, pulling back the lips into a hideous "grin," making it look as if the individual was dying laughing, which is the effect a particular convulsive and lethal plant from the island of Sardinia (hence "sardonic") also has on its victim. Some tales portray the burning alive of these hapless infants, while others tell of the high priest slitting the throat first and then throwing the corpse into the fire. Another contradiction lies in the number of infants sacrificed at one time. Some stories refer to individual offerings, one infant at a time. Others, however, tell of mass sacrifice. It is the latter version that caught Flaubert's imagination and became embellished in his epic poem *Salammbô*. Here we are told how the Carthaginian mothers gave up their children to the priest, who hurled them into the flames of sacrifice while musicians played loudly to try to drown out the wails of mother and offspring alike.

Who were supposed to have sacrificed their children? The inference, largely from the inscriptions on the stelae in the Bardo Museum and from much less complete inscriptions, is that upper-class Carthaginians were subject to this ritual, at least in the earlier periods of Carthage. But references to "judges," "magistrates," and "priests" eventually become supplanted by an array of everyday professions, such as doctors, weavers, and sailors. According to Diodorus Siculus, a Carthaginian could also take or buy a child from an even lower class family to use in sacrifice.

A last piece of the sacrificial picture is that the child offered in sacrifice may often have been a son, the first-born son. This detail

derives from a series of historical connections. In the Old Testament, in Jeremiah, the people of Judah are recounted as having built a tophet, just to the south of old Jerusalem, where they burned their children. The Carthaginians were Phoenicians and their original homeland was Phoenicia. The Phoenicians carried their alphabet far and wide, and from it, via Greek, Latin, and other derivatives, the alphabet we use developed. Phoenicia was also the land of Canaan, the home of the Israelites; as such, it would be quite natural for cross-cultural assimilation and influence to have occurred between the Israelites and the Phoenicians. A common practice among Near Eastern cultures was the offering of the "first fruits"—human or otherwise—to the deities and reference is specifically made in Exodus to the giving up of the first-born son; in fact, in the Old Testament, all but one of the instances of human sacrifice (whether just promised or actually carried out) entail the offering of the first-born male. Ergo, the Carthaginians were sacrificing their first-born sons.

The urn processing set-up at the dig house. The red, water-filled bucket on the left contains an urn that had come in from the field. The contents of urns already "excavated" using the hose technique developed by the author are spread on individual meshes and rinsed until all sediment is removed. The now-empty urns are kept in association with their contents until the drying and sorting phases of the procedure are completed.

The reference in the Old Testament to a "tophet" is to a place of sacrifice, not a place of burial nor one in which both the sacrifice and burial took place. The word "tophet" was later used to refer to the cemeteries, such as at Carthage, where the burned bones of infants and animals were interred in urns. So far, however, there is no convincing evidence of a tophet—a place of sacrifice or the altar of sacrifice—in what was Canaan. There is also nothing in what was Canaan or Phoenicia comparable to the "tophets" found at Carthage and other Carthaginian cities of northern Tunisia and in Carthaginian colonies in Sicily and Sardinia.

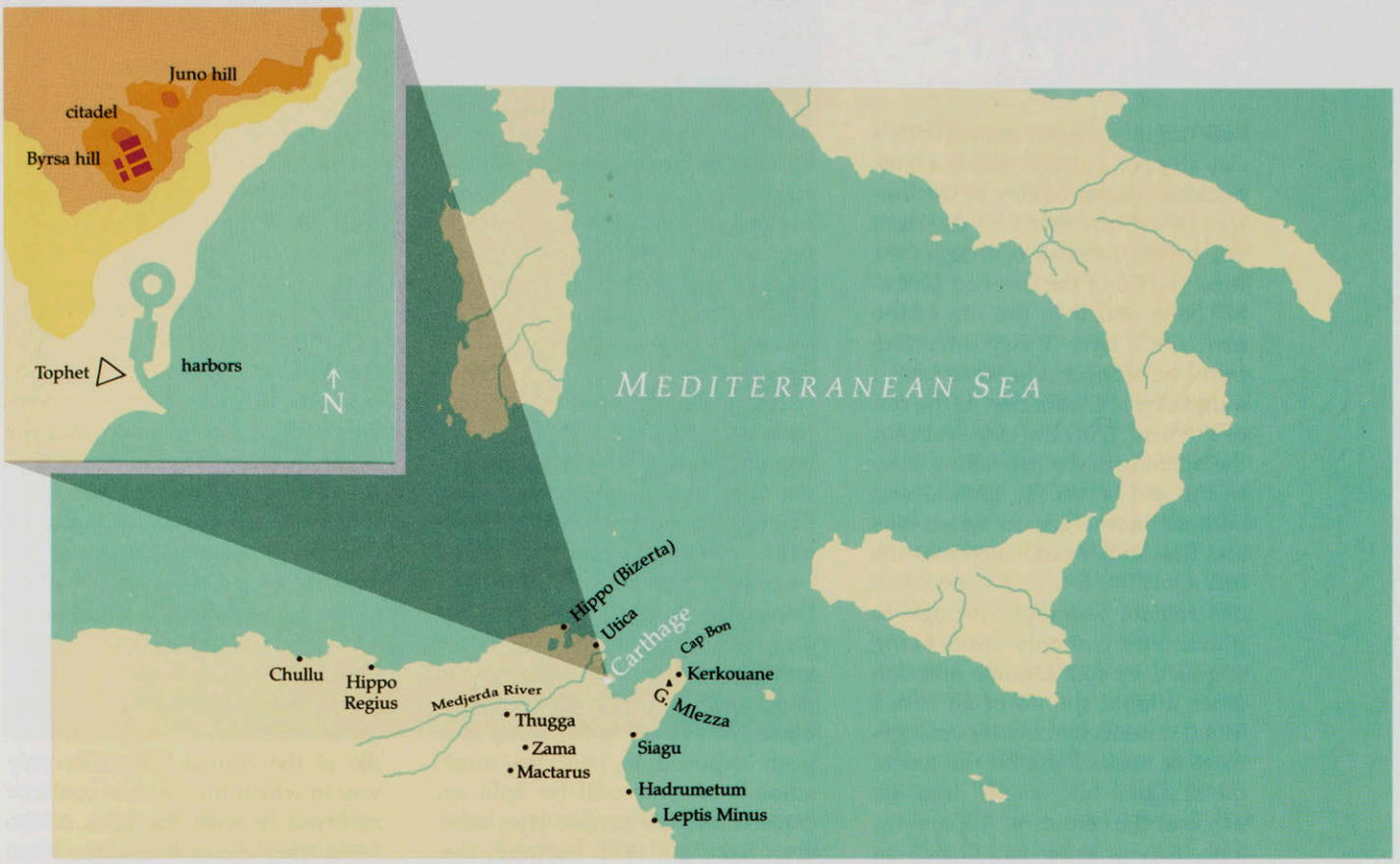
Most biblical and classical archaeologists and scholars have accepted the interpretation that the reason we find tophets at Carthage and other Carthaginian sites is because the Carthaginians were practicing human infant sacrifice. In addition to accepting the faithfulness of the reporting of the biblical and classical references and inferences summarized above, these academics have also placed great weight on the fact that there is something "special" about a tophet. It is an area in which one finds only the remains of very young humans, and their bones are burned. It is an area where one also finds the burned remains of animals, and it is known that animal sacrifice was widespread throughout contemporaneous Mediterranean civilizations. If this is a place in which to bury sacrificed animals, it could also be the place in which to inter anything that had been sacrificed, whether it be human or animal.

Excavating the Tophet and Excavating the Urns

Although previous excavations of Carthage concentrated on the Tophet, little effort actually went into the analysis of the bony contents of the urns themselves. As was often the case, attention focused on the more spectacular archaeological finds, in this case the grave markers, the amulets, beads, and other artifacts in the urns, and the urns themselves. Until my involvement in the recent excavations of the Tophet, the only osteological analysis in the literature on an unmixed sample from Punic Carthage alone was done by P. Pallary, who reported in 1922 on funerary urns ("les urnes funéraires") recovered the year before during the first excavation of the site by "MM. Icard et Gielly" and others. Thousands of urns and gravemarkers have been excavated over the many succeeding archaeological campaigns, but the analysis of the urns and their contents did not receive top priority.

In 1979 I was given the opportunity by the Conservateur du Site du Carthage, Institut National d'Archéologie et d'Art, to study some of the bones recovered during the joint French-American archaeological campaign of 1925 led by Francis W. Kelley of the University of Michigan. I was presented with three small, shallow cardboard boxes, each of which was deep enough to contain only two thin layers of cotton in the midst of which were less than a dozen minute scraps of burned bone. One could tell that the bone in these three boxes was human in origin, but that was all. Answers to any of the pressing questions, including the most obvious and easily obtainable—"how old the individuals had been at the time of death?"—could not be addressed with the paltry fragments that had managed to survive the excavators' hands.

Excavating the urns from the Tophet at Carthage was no mean



Map of the central Mediterranean showing Phoenician cities around Carthage in northern Africa. The insert is a detail of ancient Carthage.

feat. The water table has risen since the Tophet had been in use so that pumps had to be kept going nonstop to expose the urns. I was glad that my task began when the urn came out of the ground—actually mud—but it quickly became apparent to me that the water was going to be a problem long after I received an urn from the field.

The first time I went to work at Carthage, in 1976, teaching obligations forced me to arrive at the site after the digging season had begun. The urns that had previously been excavated had been stored in and around the dig house and had dried out. With an array of dental picks, spoons of different sizes, and brushes I tried to "excavate" the contents of an urn. It was like digging through cement and getting your hand caught in the cookie jar at the same time. The mouth of the urn was just big enough to get your hand into, but the bone had become incorporated into a solid block that now filled the inside of the urn. With the evaporation of the water in which the urns had been standing for centuries, the dissolved minerals solidified, cementing together everything in the urn. After a few excruciatingly tedious, frustrating, and essentially useless attempts to scratch away the hardened mass and rescue anything osteological, I knew there had to be a more efficient way in which to proceed.

The solution was simple: don't let the urns dry out. As soon as an urn was delivered to my work area at the dig house, I or an assistant filled the bucket containing the urn with water. The urn could stay like that indefinitely, but it was usually processed within twenty-four hours. "Excavating" an urn was done with a gentle stream of water from a garden hose flushing the contents onto a fine plastic mesh. Once emptied, the urn could dry without harm. The material that had been collected on the mesh was rinsed clean of soluble minerals and spread out to dry in a single layer. Separation of the various components—the bone, the charred wood, the artifacts if present, fragments of the urn or its lid, or the clay stopper that had sealed the urn—began with the rinse phase and was completed the next day, when the material was dry. The different components were bagged for analysis by the appropriate specialist.

It was astonishing to see how much could be salvaged from the better preserved urns with this simple "garden hose" technique. To be sure, there were often hundreds of flakes and chips of bone that were at best identified grossly to the part of the skeleton from which they had come. But there were also often whole teeth, and sometimes parts of upper and lower jaws and skulls, and even complete finger and hand bones and long bones of the arms and legs. One could actually do something with this material.

Most of the urns we excavated were in reasonably good condition: even if it had cracked while in the ground, an urn could provide a fairly protective shell around its contents. It appears that each urn

An urn from the Tophet and the burned human infant bones and array of beads, amulets, and other small items placed in it; the urn separated into large fragments after being removed from the ground. The udjats, representing the eye of Horus, are the white, intricately carved amulets clustered toward the bottom, to the left of the beads. The light colored beads are spun glass (the Phoenician art of spun glass making is now lost) and the smaller, darker beads are made from the semi-precious stone carnelian.

had originally been sealed with a clay stopper. I always found a thick pucklike clump of clay at the bottom of an urn that was the right size to have fit in the opening of the urn. The lid of the urn had probably been sealed to the rim of the urn with a layer of clay extending from the stopper. On some urns I found clay still adhering to the rim of the urn. With the clay seal over the opening of the urn falling away as the urn lay in the ground and became submerged in water, silts and fine soils would seep into the urn. Only in a few instances did an urn remain watertight enough to prevent its contents from being engulfed by soil. On one occasion when I lifted the lid of an urn, I found a perfectly circular arrangement of beads lying on the top of the soil that had seeped into the urn over the centuries. Apparently, a necklace of beads had floated on top of the rising water, and, eventually, the cord of whatever nonmetallic string on which the beads had been strung had decayed. The heavier bone, wood, amulets, and rock that were in the urn had stayed at the bottom.

In addition to being relatively well sealed, another sign that an urn had held together fairly well over the years was the presence of a reasonable amount of bone. What constitutes "reasonable" is difficult to define because each urn represented a different set of problems and conditions to take into consideration. Two major factors enter into the evaluation: the apparent age of the individual and the extent to which the individual's bones had been burned. The younger the individual—and the vast majority were less than one year old—the more cartilage and membranous tissue there is contributing to the skeletal framework. Such soft tissue would not survive burning any more than it would survive normal burial. Furthermore, the younger the individual, the thinner the bone that had been deposited and the more susceptible it would be to damage and dissolution. The destructive forces assaulting these fragile skeletal elements were, first, fire and then the collecting and putting of the surviving bony pieces into an urn. Water, which would eventually envelope everything, probably did not do any further damage.

The intensity of the fire also makes a difference. The longer a bone is exposed to flame, and also the more intense the fire is during the time a bone is exposed to it, the more "calcined," or on the way to becoming ashes, the bone becomes. With longer or more intense exposure to heat, bone loses its water and organic components and becomes more fragile. Often the surface of bone that had been exposed to heat for some amount of time will be split or cracked and the surface layer may even flake off. With burning, the color of bone changes from brown to charcoal to steel blue to white. White bone is the most calcined. Beyond white, bone is completely incinerated and lost. The surface or surfaces of the bone closest to the fire will be more calcined than the others. A bone lying across a fire of uneven intensity will be unevenly calcined accordingly.

Given these factors, it is not difficult to appreciate how fragmentary and fragile the bone that survived burning would be. No matter what the reason for the burning of the bones—sacrifice or merely cremation—they would then have to be collected and placed in an urn. Since all urns contained wood charcoal (which would have remained after the fire died out) and sometimes small rock fragments (from the surface on which the wood had been placed?), it would seem that particular care of the surviving bone had not been taken. An intact bone could, as a result, become a fragment, or a fragment even more fragmentary.

Those parts of the body that stood the greatest chance of survival throughout the entire sequence of events would be the densest or the hardest. In infants, the densest bone of the body lies at the base of the skull. This is called the petrosal bone. One end of the petrosal bone faces the outside or "ear side" of the skull, the other end points inward toward the middle of the skull, its upper surface faces up into the braincase, and its lower surface is oriented down into the neck. The spatial relationships of the petrosal bone became very important in my analysis of how the head, at least, of the infant was positioned relative to the fire. Often, I could identify a gradient of burning or calcination of a petrosal bone: the end that faced the ear would be more affected by fire than the end that faced toward the middle of the cranial base. The only way in which this pattern could be achieved is with the back of the head lying closer to the fire than any other part of the skull. It would therefore appear that individuals were often placed on their backs and that they did not move. Even though young infants cannot turn over when placed on their backs—but I am reluctant to speculate about what would happen under these crematory circumstances—we cannot rule out the possibility that the individuals were either not conscious or not alive when laid on the fire.

In addition to intact petrosal bones, teeth, or at least the crowns of unerupted teeth, were frequently found. The preservation of teeth is common in other circumstances as well. Paleontologists often find fossils of extinct mammals in the form of preserved teeth. The reason for this is that when the developing crowns of teeth calcify, they become extremely hard and are usually the parts of the body that are most resistant to destruction. For my purposes, the presence of teeth was important in trying to determine the age of the individuals in the urns. Within certain limits of accuracy, the average ages at which

crown calcification, root development, and eventual tooth eruption occur are known for modern humans and such information could be applied to the Carthage sample. It seems that the vast majority of the human individuals interred in the urns at Carthage were less, far less, than one year old. More specifically, the majority could be classified as being "perinatal." By this I mean that, given the limits of extrapolation of modern developmental data of known origin to this unknown sample, it is possible that some individuals could have been premature infants, others true term newborns, and still others one or even two months old. It would be rash, I think, to expect greater accuracy than this.

As I mentioned earlier, other parts of the skeleton were sometimes preserved intact and could be identified with little difficulty. Very often there were parts of arm and leg bones, the various pieces that fuse in the teen years to form complete vertebrae or hipbones, and those elements that contribute to the formation of the cranial base and vault and face. As small as they were, I could usually find some of the hand and foot bones, especially when an urn happened to contain a lot of bone. The more elements from the full extent of a skeleton I could identify, the more certain I could be about how much of an individual had been put in an urn. It seems that complete individuals had been placed in urns. This would obviously not be possible if mass sacrifice, or mass cremation, had been the form of the ritual. The observation that various parts of the skeleton had not become fused through normal development to become larger, more complete bones adds further weight to the dental evidence that the skeletal remains are those of very young individuals.

Another piece of information that has come out of my analyses so far is that some urns contained the remains of more than one individual. This observation was unexpected, but is a natural consequence of the discovery in an urn of duplicate parts of the skeleton. The most frequent clues to the presence of more than one individual come from duplicate petrosal bones and teeth. Sometimes, but less frequently, there is clear duplication of limb bones, or other parts of the cranium, but the ever-present fragmentary nature of the material tends to interfere.

When I was first sorting the material in the field, I was left with the impression that, when there were two individuals in an urn, one was a neonate and the other perhaps two or even four years older. This seemed to be borne out with my first laboratory analysis of some of the material we first excavated. However, with experience gained over the years in analyzing and reanalyzing the large sample I now have—the skeletal remains from more than 400 urns—I have since found that, in most instances, one individual was indeed perinatal, and although older, the other individual was only slightly older, being typically less than one year old and often not older than six months. The study is till going on, and, with each reanalysis, a few "single individual in an urn" data sheets become retitled "two individuals in an urn." Of the 257 urns so far scrutinized in detail, approximately 55 percent seem to have contained the remains of only one individual and approximately 25 percent held the remains of two individuals. By the time the entire sample is similarly picked over, I predict that these percentages will change.

More questions are raised than potentially answered when considering the presence of two (and even more) infants in the same urn, especially when one individual is perinatal and the other is not appreciably older. Obviously, it would seem, these individuals could not be related to each other, at least as siblings. Was one born dead and then cremated and the other—but from what family source?—sacrificed to appease the gods for the calamity that befell the former individual? Had both died of "natural causes" and then been cremated? Were both individuals sacrificed? At present, I would be reluctant to place more weight on one suggestion than another, but, if pressed, would favor the

Carthage: A Mosaic of Ancient Tunisia

Through January 7, 1990

Carthage: A Mosaic of Ancient Tunisia presents the most comprehensive view of ancient Tunisian life and culture ever exhibited in the United States. Enormous brightly colored mosaics, outstanding Roman bronzes, and a collection of rare Punic jewelry paint a picture of the region as an ancient center of culture, history, and art.

This exhibition is organized and sponsored by the American Museum of Natural History, New York City. The art objects and artifacts are on loan from the Institut National d'Archéologie et d'Art, Tunisia. The exhibition is funded in part by the National Endowment for the Humanities and is supported by an indemnity from the Federal Council on the Arts and Humanities. It is sponsored locally by Chase Manhattan Corporation and Royal Athena Galleries, with additional support from Ralph Khelil.

interpretation that one or both had died "naturally."

Of the remaining urns, 3 percent preserved evidence of three individuals and the contents of one urn indicated the presence of four individuals. The problems of interpretation raised above for instances of two individuals being in the same urn are also certainly relevant in these cases. Twenty-one of the urns contained human and animal remains together. I would here suggest that the animal was sacrificed and its cremated bones placed in the urn with the cremated bones of the human, who may not have been sacrificed. The remaining urns yielded only animal bones. In twelve of the animal bone cases, the preserved bones were clearly those of sheep. As with the humans, the animals were infant.

What can an osteologist conclude from the bones about human sacrifice being practiced at Carthage? Nothing. One can distinguish human from animal bone. One can with some accuracy determine the age of the individuals at death and the number of individuals in an urn. One can tell if the bones were burned and, if so, how burned they are. One can also attempt to reconstruct the position a body was in when it was burned. I am now going back over the skeletal remains to see if enough of a certain region of the hipbone is preserved to allow a determination (or, at least, an educated guess) of the sex of the human individual; with regard to the sheep, identification of the beginning of horn growth in five in the individuals, in addition to other skeletal features, would indicate maleness. But the closest an osteologist can come to any statement about ritual is that the bones were burned and placed in urns.

Some biblical scholars in recent years have questioned the interpretation that all individuals interred in the Tophet at Carthage—or any tophet—were the victims of sacrifice. Surely, it would seem, the burned bones of animals were the result of sacrifice. But animal sacrifice was common among a diversity of cultures at that time, and well after. The archaeologists Claude Schaeffer and Hélène Benichou-Safar have suggested that many of the humans in the Tophet died of natural causes. From a purely osteological perspective, this suggestion is not without merit: the vast majority of the individuals were less than one year old at death and many were perinatal. Infant mortality rates are not known for ancient Carthage—or, actually, for many earlier civilizations—but it would not be unreasonable to think that they were at least moderately high. Thus, at this level of information and speculation, one cannot rule out the possibility that at least some perinatal individuals died a "natural death" (e.g. were stillborn or died shortly after birth) and were subsequently cremated.

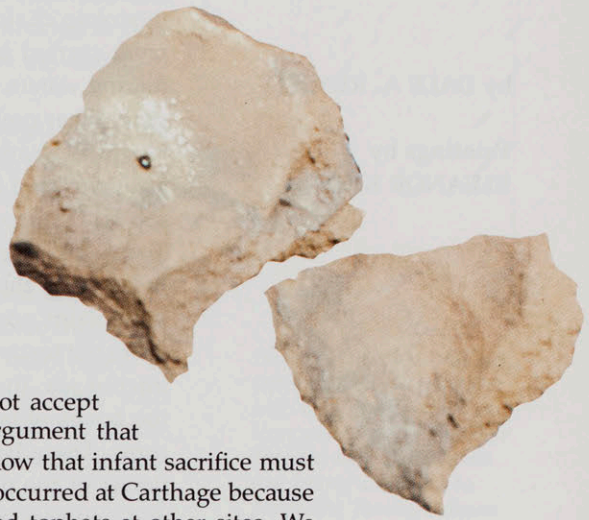
Infant and child burials outside of the Tophet are rare at Carthage. Most of them date to later than the fifth century B.C.E. and constitute fewer than 5 percent of the approximately 2,000 burials excavated to date. The burials so far discovered outside of the Tophet include adult and subadult individuals; if there are younger individuals, they are typically older than four years of age. Because most of the infant burials known from Punic Carthage come from the Tophet, Benichou-Safar has argued that the Tophet may have been a burial area for only young individuals, some of whom had been sacrificed (and this would include the animals) while others had died of natural causes and had then been cremated. The osteological evidence from the Tophet is not in conflict with this interpretation. Benichou-Safar's suggestions have, however, drawn some criticism from other archaeologists because the known non-Tophet infant burials are shal-

Pieces of a clay stopper from one of the urns. What is interesting about this stopper is that the finger and thumbprints of whoever sealed the urn many centuries ago are still visible.

low, causing critics to suggest that these infant burials just did not survive over the centuries. In contrast, the infants buried in the Tophet are contained in urns. The adult burials outside of the Tophet were usually deep, with a vertical shaft dug into the ground or rock, off of which at various depths individual tombs were dug laterally into the walls of the shaft.

From my experience, and the growing literature on the survival of buried bone, it would seem extremely unlikely that all bone from a shallow burial—typical for the infants buried in areas outside of the Tophet—would be missing from the area of original, intentional burial if natural forces of soil deposition and soil movement were left to proceed uninterrupted. For example, more than a century ago, Charles Darwin demonstrated how much the lowly earthworm had an effect on the movements of the earth, causing objects to sink into it. Over the past year, Peter Andrews, of the British Museum (Natural History), London, has been conducting additional experiments on the effects of earthworms on the redeposition of bone. Peter has found that, within weeks, the dissociated skulls and other bones of dead and decaying rodents on the surface of the ground can end up quite deeply buried in the soil layer, just from falling down an earthworm channel. If there had been a greater number of infant and child burials at Punic Carthage outside of the Tophet, I would expect that some bone would be recovered by archaeologists, even if the bulk of the bones had been washed away subsequent to burial. If, however, humans were digging up the desiccated skeletons of infants and children from known burial places, there would probably be a greater likelihood that a shallow grave would be "cleaned out" of interred bone. Allowing for the fact that the following suggestion is pure speculation, one possibility that has not been considered is that of secondary burial with cremation. In other words, after being interred in a shallow grave for a requisite amount of time, an infant burial was dug up, the bones cremated, and then reburied in an urn, perhaps with beads and amulets, in a special place—the Tophet. Secondary burial—the exhumation of buried human remains and their reburial elsewhere—is quite common among human societies, past and present.

The picture of what really happened is, of course, quite complicated, and we will probably have to compromise on our pet interpretations in order to reach any potentially valid consensus on how and why the Tophet at Carthage—or any tophet—came to house urns containing the burned bones of very young humans and animals. I can sympathize with those who have suggested that the Carthaginians did not practice any human sacrifice and that this horrible image is nothing more than anti-Carthaginian propaganda. For, after all, where are all the elephants and horses Appian wrote had been housed around the rectangular harbor? And it is the case that one cannot tell at all from the Tophet bones whether or not an individual had been sacrificed. I am not, however, prepared to dismiss entirely the interpretations of the epigraphic notations on the stelae and the historical writings as being entirely fictitious in content. But I will not accept the argument that we know that infant sacrifice must have occurred at Carthage because we find tophets at other sites. We still need to do a lot more analysis and thinking about the subject before we can say that we have unraveled the riddles of the Tophet.



Dr. Jeffrey H. Schwartz is an associate professor of physical anthropology at the University of Pittsburgh and a research associate at the American Museum of Natural History (New York) and the Carnegie Museum of Natural History (Pittsburgh), and has conducted human and animal skeletal analyses on various archaeological sites in Israel, Cyprus, and at Carthage, Tunisia. Dr. Schwartz is also involved in paleontological and comparative anatomical research on aspects of primate evolution. His works include over fifty articles on these subjects, a book (The Red Ape, *Houghton Mifflin, 1987) on the potentially close evolutionary relationship of the orang-utan and humans, and an edited volume* (Orang-utan Biology, *Oxford University Press, 1988). He is currently writing a textbook on human skeletal analysis (OUP) and a monograph,* Bones: Bias and Interpretation in Archaeology, Paleontology, and Forensics *(Holt), in which his work at Carthage will be featured.*

THE FLOWER OF THE DINOSAUR WORLD

The Late Cretaceous in North America

by DALE A. RUSSELL

Paintings by
ELEANOR KISH

A Cretaceous Camelot

During all of late Cretaceous time in North America (between roughly 90 and 65 million years ago) the level of the oceans stood higher than now. The continental margins and broad, slowly subsiding interior troughs were flooded by the sea. Sediments shed from bordering mountain chains and ancient continental shields were carried by streams directly into nearby marine waters, and so for the first half of this period they preferentially preserved an abundant record of marine life. Dinosaur bones sporadically dropped from floating carcasses washed to sea in floods or storms. Only very rarely did skeletal fragments reach the bottom of the sea. But during the latter half of this long period, floodplains and deltas spread from the western shore out toward the center of the interior sea. In them were buried the bones of land-dwelling creatures. These bones represent the flower of the dinosaurian world, and nowhere else on Earth have dinosaur bones been found in such abundance.

These dinosaurs exhibited a sophistication of form that was not so apparent in their predecessors. Although some were giants, body weights tended on average to be less than in earlier eras, bodily contours were more graceful, and limbs were relatively longer. Many had brains that were larger in proportion to their bodies than in modern reptiles. These attributes imply that metabolic rates and activity levels had increased to become transitional to those typical of modern warm-blooded birds and mammals. Accompanying relatively advanced physiologies and behaviors was a differentiation of basic body patterns into a large number of distinctive varieties, adapted to the numerous ecological variations of the lowland environmental theme. It was a world more full of evolutionary excitement and potential than had ever existed before on the planet. The record of lowland life is best sampled in strata representing the last dozen million years of late Cretaceous time. Because of the relatively short span of time, the interplay of ecologies is much more obvious than the effects of further evolutionary achievement.

Nowhere else have dinosaur bones been found in such great abundance.

Dramatis Dinosaurae

Dinosaur faunas of the late Cretaceous of North America were dominated by five major kinds of large dinosaurs. Other dinosaurs were present, but they were usually either much less abundant or much smaller. Foremost among the dominants were bipedal herbivores termed hadrosaurs, a name derived from Greek roots meaning "heavy lizard." In English, they are popularly called "duck-billed dinosaurs," which has been translated as such into languages as diverse as Chinese and Russian. When shown a reconstruction of a hadrosaur, a man belonging to the Turkana people of northern Kenya dubbed it an "ostrich-camel lizard," which accurately reflects the animal's shape. Hadrosaurs had made their appearance during middle Cretaceous time in North America, Europe, and central Asia, but the more ancient forms are in general poorly known.

Hadrosaurs were bipedal walkers that bore only three blunt, hoof-tipped toes on their feet. Their necks were graceful and birdlike, and their tails were relatively long, deep, and inflexible. The teeth were grouped into elongate, inclined grinding mills. A complex system of muscle, bone, and tendon allowed the cheeks to spring apart as the lower jaws were closed, prolonging the duration of each grinding stroke. Some varieties also possessed a ducklike bill. Adult hadrosaurs ranged between 7 and 16 meters in length (23 to 52 feet), and 2 and 13 metric tons in weight. Most were closer to the smaller limit in size.

The second most abundant group of dinosaurs in the late Cretaceous of North America was the ceratopsians, or horned dinosaurs. In some areas they seem to have been even more common than hadrosaurs. Probably a few tens of millions of years previously, these rhino-like herbivores had evolved from bipedal ancestors, and their bodies had become compact and barrel-shaped. By dinosaurian standards their heads were huge. Their beaks were high and narrow, and a ball joint between the skull and the short neck allowed the animals to turn their beaks parallel to the ground. The extremely powerful jaws were

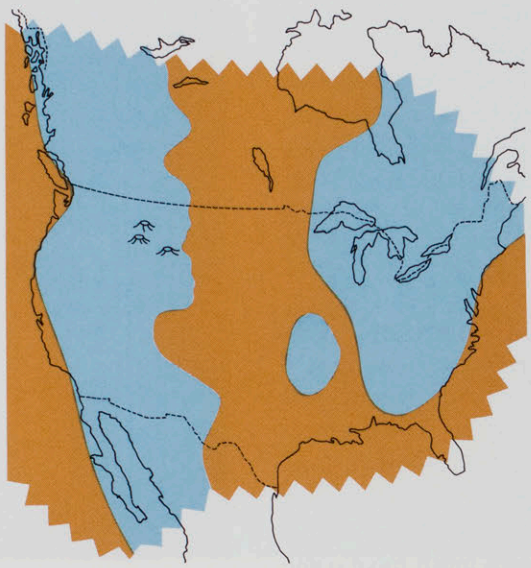
adapted to chopping up plant materials, but they lacked the spring-grinding mechanism of hadrosaurs. The horns and bony shields extending over the neck were obviously used in self-defense, and the presence of puncture wounds in some shields indicates that the enemy could be another horned dinosaur. The broad feet bore five digits in front and four behind. The tail was relatively small and round. Adult ceratopsians ranged between 4.5 and 8.5 meters (15 to 27 feet) in length and 3.5 and 19 metric tons in weight.

A third group of plant-eating dinosaurs, which migrated to this continent from Asia probably during late Cretaceous time, was not abundant but was quite interesting. This was the ponderous, heavily armored ankylosaurids. A bony cuirass extended from their eyelids, cheeks, and plated nostrils, across their broad back, and onto the tail, which ended in a club. The bones of the pelvis and the ribs (and in at least one instance those of the shoulder girdle) were immovably fixed together to support the body shield. Impressions of soft tissues preserved on the bones of the skull indicate that the animals had poor eyesight and a keen sense of smell. Complicated scroll-like bones in the snout possibly supported membranes that increased the humidity of inhaled air or served as heat-exchangers to cool blood flowing to the brain. A squared-off muzzle suggests that the animals, alone among their large dinosaurian contemporaries, cropped small plants growing on the ground. With a short neck and rigid back, they probably moved their heads among herbaceous vegetation by movements of their forelimbs. Low metabolic rates and a sluggish mode of existence are suggested by a very weak dentition, a relatively small brain, and a passive mode of defense. Adult ankylosaurids ranged between 6 and 8.5 meters (20 to 28 feet) in length and 2 and 6 metric tons in weight.

The carnivorous tyrannosaurids were undoubtedly a plague for plant-eating dinosaurs. These large-headed bipeds, with their dagger-filled jaws and tiny, two-fingered forelimbs, are among the most famous of all dinosaurs. However, their skeletons have been identified with certainty only in North America and central Asia. Other groups of carnivorous dinosaurs were more common in Africa, South America, and India. Tyrannosaurids are also restricted in time to the last dozen million years of the dinosaurian era.

Tyrannosaur bones evoke an image of a terrifying predator with a streamlined and efficient body structure. A brutish, bulldog neck, powerful chest, feline hips, and lanky legs imply that the animals were active hunters. An interlocking array of riblike bones protected their bellies from erratic horn thrusts of hapless herbivores. A large pelvic bone with an expanded end probably supported the animal's body in a prone position, buttressed on each side by the flexed hind limbs. Lying next to a toppled tree or among high vegetation, tyrannosaurs, like lions, could wait in ambush for their prey. There were large, wartlike growths on the ridge of the muzzle. Their function is difficult to imagine, unless they served to enhance an already stunningly repulsive appearance. Is the antithesis of beauty a matter of consensus between hadrosaurs and humans? Widely spaced teeth lining the sides of their jaws suggest that tyrannosaurids were rather messy feeders. They did bear tiger-like nipping teeth in the front of their upper jaw, which enabled them to clean a carcass somewhat more effectively than other large flesh-eating dinosaurs could do. The several varieties of tyrannosaurs ranged between 9 and 12 meters (29 to 39 feet) in length and 1.7 and 5 metric tons in weight.

The last of the five groups of typical late Cretaceous dinosaurs on this continent was the ornithomimids, or ostrich dinosaurs. The ancestry of the group is remote and extends back to late Jurassic time, when the South Atlantic Ocean had



North America and its interior sea during the late Cretaceous (75 million years ago). Former Pacific island terrains are being crushed to form the Rocky Mountains. Along the western margin of the interior sea, eroding highlands produce deltas that contain abundant dinosaur remains.

Land

Water

not formed and African and North American dinosaur faunas mingled. Ostrich dinosaurs in a sense can be considered tyrannosaur parodies. In details of the construction of the feet and in the presence of tiny wartlike pits on the nose they resembled tyrannosaurs. But where the tyrannosaurs had teeth, ostrich dinosaurs had none. Tyrannosaurs had large bodies and tiny forelimbs, while only the eyes and the forelimbs of ostrich dinosaurs were large. Where a tyrannosaur would attack, an ostrich dinosaur would flee. Indeed, the ornithomimids were among the fleetest of dinosaurs, evidently possessing the speed and brains of modern ostriches. Although such a proportionally great amount of cerebral equipment was quite respectable by dinosaurian standards, zoo-keepers consider ostriches the most stupid of the large animals under their care. The arms of ostrich dinosaurs were not unlike human arms, although the wrists were less flexible and the three digits of the hand were longer and ended in claws. The animals were probably omnivorous, subsisting on eggs, small animals, or fruits. Adult ostrich dinosaurs ranged between 3.5 and 4.5 meters (11 to 15 feet) in length and between 10 and 150 kilograms (22 to 330 pounds) in weight.

Cordilleria and the Continent

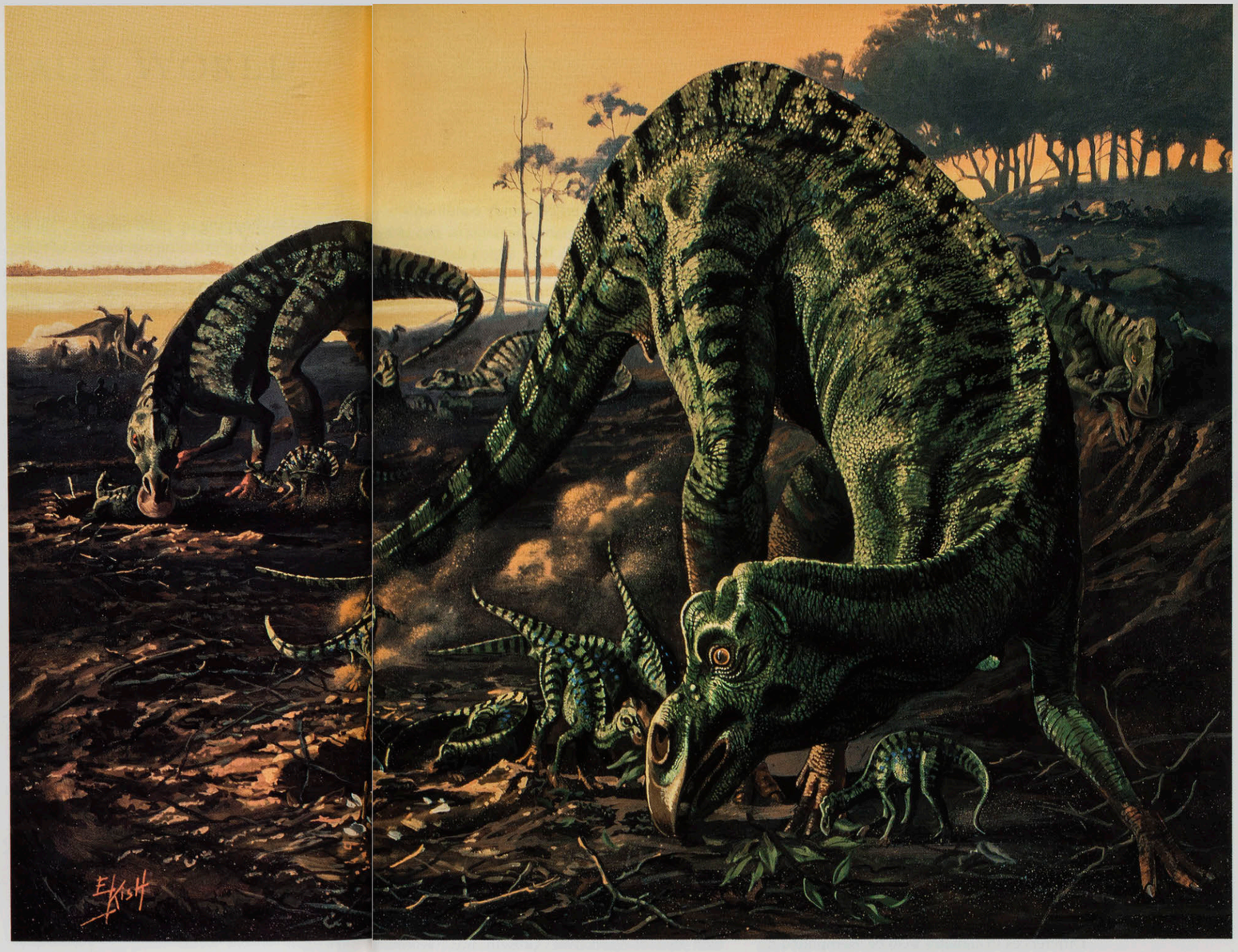
By late Cretaceous time North America had long been a continent, but it was far different from the continent we know today. The combination of a much greater extent of coastal environments and influence of maritime climates, as well as greatly reduced seasonality, would have made modern North America seem much more continental, like central Asia, according to the standards of its late Cretaceous inhabitants. Greenland was linked by land to northern Eurasia through the islands of Spitsbergen, north of Scandinavia, and the spreading axis of the North Atlantic rift system temporarily passed through Baffin Bay to the Arctic Ocean. South along the Atlantic seaboard, and the northern margin of the Gulf of Mexico, the edge of the continent was essentially the same as it is now, although the coastline passed inland from New York City through the vicinity of Washington, DC, Charleston, South Carolina, and Columbus, Georgia, and curved to the northwest through Tuscaloosa, Alabama, toward Memphis, Tennessee.

The eastern part of the continent was separated from western lands by the great interior seaway, which was more (often far more) than 500 kilometers (375 miles) wide, and crossed eastern Mexico, the plains states, the prairie provinces, and the Northwest Territories to enter the Arctic Ocean. At various times, arms of the interior sea isolated the Ozark Highlands and the northeastern part of the Canadian Shield from the main part of the Appalachian land mass. The biological consequences of the division of the continent into two major land masses must have been substantial.

Even the mountains were not immutable. A perusal of a topographical map of North America reveals that the Canadian Rockies are unique. Nowhere else on the continent can one fly over such a vast expanse of formidable terrain, composed of range after range of spectacular mountains. They rise from highlands in northern Washington, Idaho, and Montana and continue north through British Columbia and Yukon to fan out in Alaska south of the Brooks Range. At the beginning of Cretaceous time the Canadian Rockies were not part of the continent. They were coalescing from volcanic islands arcs brought together through the convergence of great crustal plates beneath the Pacific Ocean, a thousand kilometers (750 miles) or more to the southwest, off the coast of California.

Like New Zealand, New Caledonia, and other large islands in the southwestern Pacific today, this newly amalgamated mini-continent, which has been named Cordilleria, probably carried a distinctive assemblage of indigenous plants and animals. Many were probably the living fossils of their day, and the remainder would have been carried to it by chance on natural rafts of vegetation floating on ocean currents or perhaps on the wings of giant pterosaurs. In modern times, island organisms often do not compete well with those inhabiting continental land masses. So far no record of land life has been found on Cordilleria from when it was an island.

The same kind of crustal movements that formed Cordilleria carried it toward North America, and later in Cretaceous time its northwestern edge contacted the North American land mass in northern Alberta. Cordilleria was then rotated in a counterclockwise direction, and about 75 million years ago its entire eastern coast was brought into contact with the west coast of North America. The old west coast was crumpled in three major phases over the next 20 million years, so



Maiasaura (good mother lizard) with its young in Montana, 75 million years ago.

that along the latitude of the international boundary its crust was shortened by 200 kilometers (124 miles). Thus, 75 million years ago, sediments washed from old island highlands began to fill the western margin of the interior sea in Canada. To the south the sea continued to dominate the middle of North America. Perhaps the collision of Cordilleria created land-bridges to Asia that allowed tyrannosaurs, ankylosaurids, and tube-headed hadrosaurs to migrate to this continent. And perhaps the resulting changes in atmospheric and oceanic circulation precipitated the turnover of marine faunas in the interior sea.

The Weather in Camelot

The single most important factor governing the climate of a region is its latitude. During late Cretaceous time the North Pole was located 2,500 kilometers (1,875 miles) away from its present position. It was situated directly on the Alaskan-Siberian land-bridge, and the entire latitudinal grid was displaced so that the west coast of North America lay relatively to the north, and the east coast relatively to the south, of their present positions. Climatic zones were similarly shifted. Animals migrating to Asia from western North America would have had to cross the North Pole. The route from eastern North America to Eurasia was located 3,200 kilometers (2,400 miles) further south. Alaska and Yukon lay entirely within the polar region. The northern interior plains were at about the same latitude as they are today, while the Appalachian region bordered on the tropical zone.

Differences in climates may be exemplified by the kinds of plants that grow under various climatic conditions. During late Cretaceous times, plants were generally only distantly related to their modern counterparts, so that climatic conditions can better be deduced not on the basis of the habitats of related living species but rather by examining the adaptations of the ancient plants themselves. Thus small vessels in wood can indicate freezing temperatures, large ones can indicate rapid evaporation in warm air, and growth rings record conditions only seasonally favorable for growth. Leaves are very sensitive indicators of air temperature, humidity, wind velocity, and seasonality. For example, large leaves with toothed margins indicate cool, wet climates; small ones with spines suggest dry conditions; smooth-margined leaves with drip tips occur abundantly in warm, humid environments; and long, slender leaves reflect windy conditions.

According to the plant adaptations, the temperature in the Appalachian region did not vary greatly from a pleasant 20 to 30 degrees Celsius (68 to 86 degrees Fahrenheit). Rainfall was not heavy, but it was distributed evenly throughout the year. The trees were not tall and were widely spaced, so that they did not shade each other. They were well adapted to conserve water, so that humidity levels were low. Some of the taller broad-leaved trees bore long, narrow leaves, and scattered conifers towered over the bushy forestlands. There were few vines, and the larger trees probably had flat or gently rounded crowns as they do in open forests in low latitudes today. Similar vegetation still occurs in certain areas of Indonesia, but warm, subhumid environments in which seasons are lacking have essentially disappeared from our planet.

In the northern midlatitudes, in the region of what has become Montana and Alberta, the mean annual temperature was several degrees cooler. Rainfall may have been more abundant, but plant growth was thus subjected to seasonal changes in light and precipitation, and the forests were composed of an entirely different suite of trees. The leaves were of average size, and most were carried throughout the year. The trees tended to be taller, and some supported vines.

In Alaska and Yukon a large part of each year passed beneath the polar night, but there was no frost. The mean annual temperature remained near 10 degrees Celsius (50 degrees Fahrenheit), and in many respects the humid climate resembled that of Vancouver. Growth was vigorous during the season of light, and the trees shed their very large leaves at the beginning of the season of darkness. Deciduous conifers, such as the bald cypress, also shed their fronds. Only a few conifers with small leaves carried them throughout the year.

North America would hardly have been recognizable during late Cretaceous time. A relatively slow decline in temperatures toward the poles, the north-south orientation of mountainous areas, and the separation of the continent into eastern and western land masses by the interior sea made north-south migration easier. On a planet-wide scale, mean annual temperatures were then about 10 Celsius degrees higher, an effect caused by a different attribution of land and seas, a greater atmospheric "greenhouse" effect caused by higher carbon dioxide levels, and

perhaps other factors that have not yet been evaluated (such as a greater atmospheric mass). In the reduced effects of seasonality, and even in their absence, environmental conditions were strikingly different. No modern counterparts can be found for the warm subhumid and polar deciduous forests.

Seventy-Five-Million-Year-Old Eggs

Purplish and reddish-brown sediments are exposed on the high plains of northwestern Montana, near the city of Choteau, that long ago were deposited on a broad plain some 360 kilometers (270 miles) from the western edge of the interior sea (upper part of the Two Medicine Formation, 245 meters [805 feet] thick). They were shed from volcanic highlands in southern Montana and from rugged hills to the west that formed when vast sheets of stratified rock were pushed eastward with the impact of Cordilleria. The reddish hue of the sediments, and caliche bands in fossil soils within them, indicate that these ancient flatlands were semi-arid. The newly formed western highland had created a local rainshadow within a generally well-watered region. During the rainy season the verdant plain was dotted with ephemeral soda lakes, but during the dry season only vegetation growing near the streams remained green.

As might be expected, the semi-arid sediments contain few bones of fish and small aquatic reptiles. Dinosaur bones, however, occur in great abundance. Remains of immature animals are particularly common, and the scattered bones of babies and eggshell fragments are the most abundant of all. But only a few varieties of dinosaurs are represented in this wealth of fossil material, including a hadrosaur, a small herbivorous hypsilophodont [a small, swift dinosaur], and a small carnivorous theropod. Bones of terrestrial monitor lizards are also common. Why did so many individuals of such a limited variety of dinosaurs seek a local semi-arid environment, virtually the antithesis of an oasis, within a vast region of vegetational abundance? The dinosaurs had come in order to reproduce, and they were seeking unusually well-aerated soils in which the eggs would not be drowned. The small carnivorous dinosaurs and monitor lizards had come to devour the eggs and young.

One shallow lake was large enough to retain its alkaline waters throughout the year, and dinosaurs nested near its shore. One variety, perhaps a small carnivore, buried 10-centimeter- (4-inch-) long eggs in paired rows, many of which did not hatch. Algal banks and freshwater clams flourished on the tepid muds on the floor of the lake. A 4-meter- (13-foot-) long wing of a giant pterosaur was entombed there, perhaps as a consequence of an unsuccessful high-speed dive on a juvenile dinosaur, an aerodynamic miscalculation, and a dramatic crash onto the surface of the lake. Floods swept large banks of sand into the lake, and these were transformed into islands when water levels rose. Some became "egg islands," for they offered a partial haven for small hypsilophodonts that returned to them season after season to nest.

The hypsilophodonts deposited about two dozen eggs within a circle about one meter in diameter. They did not make an excavation but simply deposited each 15-centimeter- (6-inch-) long egg with its pointed apex in the ground in a manner so that no egg would touch its neighbor. The nest may have been covered with plant material. One clutch has been preserved in which each of the 19 eggs contains the skeleton of a tiny, embryonic hypsilophodont. When the animals hatched they immediately left the nest, for the bottom halves of the eggs are never trampled. The young were precocious and fast runners. However, they must have remained in the vicinity of the nests some time after hatching, for the bones of juvenile individuals are often found near the nesting sites. So are the teeth of monitor lizards and small carnivorous dinosaurs, and so are the pupae of carrion beetles. Life was not easy for a young hypsilophodont.

Good Mother Lizards

The dinosaur rookeries of Choteau, Montana, are remarkable also for nests of a hadrosaur called *Maiasaura* (good mother lizard), in deference to abundant evidence preserved there of the care these dinosaurs took of their young. Maiasaurs were rather small hadrosaurs, weighing about 2 metric tons and measuring 7 meters (23 feet) in length. They belonged to the flatheaded group and were relatively unspecialized creatures. Their beaks were broad and ducklike, and a small spine in the center of their foreheads served probably as a support for fleshy structures used in trumpeting. *Maiasaura* bones have been found in two circumstances that provide insights into the rate at which the animals grew.

In one association, the skeletons of adults are

The Late Cretaceous was a world more full of evolutionary excitement and potential than had ever existed before on the planet.

Two great horned dinosaurs, Triceratops, *forage beside a small lake, in a forest of bald cypress and gum trees, south of Wood Mountain, Saskatchewan.*

found near nests, or with juveniles less than 3 meters (10 feet) long. In another, a great herd was overwhelmed in a heavy fall of volcanic ash, and the skeletons were later torn apart and reburied in a mud flow. This herd was composed of animals that belonged to body-length groups of about 3, 4, 5.2, and 7 meters (10, 13, 17, and 23 feet). A simple explanation for this phenomenon is that the animals reproduced once each year and the size groups represent age groups of 1, 2, 3, or 4 (and over) years. Maiasaurs would thus have matured in 4 years and then, like modern birds and mammals, ceased to grow. Weights can be deduced from lengths, and the resulting growth rates imply that the animals doubled their weights each year until they became adult. These dinosaurs were growing more than 10 times faster than alligators, or at about two-thirds the growth rate of a mammal of similar adult body weight.

The absence of clearly defined growth rings in their bones confirms that the animals were growing at a high but uniform rate. Their tooth batteries were as sophisticated as those of modern hoofed mammals, and the area of the grinding surfaces was equally large in proportion to the hadrosaurs' weight. Hadrosaurs evidently needed to chew about as much food per day as modern mammals do. High growth rates and the need for large quantities of food are indications of a high metabolic rate. Hadrosaurs were also remarkable for their very large eyes, often twice as large as those of ostriches, and for a brain volume twice that of modern reptiles, after allowing for body size effects. Maiasaurs, and by implication hadrosaurs in general, were at least incipiently warm blooded.

Much is known, or can be inferred, of the natural history of *Maiasaura*. In a semi-arid environment it would be best to lay the eggs during the latter part of the dry season, so that they would not be smothered by wet soils. The hatchlings would emerge with the return of the rains and a seasonal flush of soft, nutrient-rich plant food. The nests were built in silty earth away from the main stream channels. As preserved, they measure about 2 meters (6.5 feet) in diameter and are surrounded by a rim about 75 centimeters (2.5 feet) high. The nesting sites occur in colonies but are never closer to each other than one adult body length. About two dozen eggs were deposited in each nest. They were in the shape of lopsided ovals, about 20 centimeters (8 inches) long, and weighed about 1.2 kilograms (2.5 pounds). The eggs were of normal proportions for reptiles the size of *Maiasaura* adults.

The adults may have shielded the eggs from extremes of temperature with their bodies and thus "sat" on their nests. Hatchlings were about 35 centimeters (14 inches) long and probably weighed a kilogram. They remained in the nests, trampling the eggshells into fragments, and wear on their tiny teeth indicates that they were fed there by their parents. Unlike the surrounding reddish sediments, the mud from which the nests were made is green, probably because of a change in the color of iron minerals caused by vegetation the parents carried to the nests. Two out of a total of eight nests examined contained dead hatchlings. The young were evidently so tightly bonded to their nest that they chose to starve to death there, rather than to leave the nest to forage on their own. One of the nests contained the remains of 15 one-meter-long juveniles, 11 inside the nest and 4 outside but nearby. The fact that a few had at least ventured beyond the nest indicates that at this size they were nearly ready to leave it altogether. The pattern and rate of weight gain in larger animals when extended to hatchlings would imply that they remained in the nest about 60 days. The brood evidently followed its parents for many months thereafter, before leaving them at the beginning of the next breeding season.

An appraisal of the "facts of life" as they applied to the domestic life of maiasaurs shows that parenthood must have been a challenge for them. If the hatchlings were sluggish, thereby efficiently channeling more energy into growth, then in order to attain a length of one meter within 60 days each would require about 1.2 kilograms (2.5 pounds) of plant food per day. A brood of 20 would need 24 kilograms (53 pounds) and at this rate the parents comprising a breeding colony would be unable to find energy-rich fruit in sufficient quantity. The young would be fed leaves and shoots, and the economics of foraging practically necessitates that both parents fed them. It would have been easier for the parents to grind up the food and carry it to the nest within their bodies, depositing it near the hatchlings as a partially digested slurry, either by regurgitation or by elimination. A complex series of interlinking problems made foraging a dangerous and exhausting process.

The energy needs of a foraging hadrosaur can be estimated from its probable weight and from the normal walking speeds of large bipedal dinosaurs calculated from trackways. A distance of about 23 kilometers (17 miles) was about as far as a maiasaur could walk and still return to its nest in one day. In order to forage, to maintain its own health, and to feed its large family, each parent had to collect perhaps 75 kilograms (165 pounds) of fodder per day. Nearby sources of food would soon be depleted, and the parents would have to range ever more widely each day. Because the nests were immobile, the parents could not disperse in order to avoid predators. One means by which prey animals minimize losses from predators is to gather in such great numbers that the proportion of animals being killed by carnivores living in the region becomes relatively small: the number of prey animals suddenly appearing in the nesting area greatly exceeds the appetites of the local population of predators. It was thus advantageous to have the greatest possible number of nesting animals in a rookery. Given the range and food requirements of the hadrosaurs in a colony, and the ability of plant growth to produce food in a semi-arid climate, an area with a radius of about 23 kilometers should have supported a maximum of about 2,700 warm-blooded hadrosaurs.

The annual nesting of *Maiasaura* took an aura of high drama. The largest breeding herd would have formed a caravan of about 2,700 animals. They would have congregated in a dry alluvial plain under a burning sun and, with much dust, constructed 1,350 nests over an area two-thirds of a kilometer in diameter. The rains came, the brushlands greened, and the nests burgeoned with stumbling, chirping hatchlings. Lines of parents streamed along muddy, dung-filled paths to and from the colony. The air was rent by sounds of breaking branches, as trees and shrubs were stripped of their foliage in an ever-widening circle of environmental destruction. The activity attracted the attention of every carnivore, large and small, within the region of the rookery. The fact that two out of eight nests were found to contain dead hatchlings poses the question of why the parents abandoned their nests. Were they victims of tyrannosaurs stalking the fringes of the nesting colony? Such a great toll of adult maiasaurs would quickly have to be replaced in order to sustain a breeding population and would in turn explain why they had to grow up so quickly. It may have been that a 10-year-old *Maiasaura* was a very ancient animal. Carcasses of dead hadrosaurs began to dot the stripped shrublands, and the area began to acquire something of the appearance of a battlefield.

The hatchlings grew, but so did the number of carnivores and the distance to unbrowsed vegetation. And the pulse of plant growth waned with the declining rains. The moment when the juvenile hadrosaurs were able to leave the nest probably coincided with the onset of conditions when they could no longer have survived in the nest. The *Maiasaura* parents departed with their broods toward greener pastures. Later in the year the hadrosaur families dissolved, but they retained their social habits. The bones of the great herd overwhelmed by a heavy fall of volcanic ash are spread over an area of 1.5 square kilometers. In it are skeletal parts belonging to an estimated 135,000 individuals. No environment could have supported a stationary group of this many large, warm-blooded herbivores. These are the remains of a migrating herd of dinosaurs.

> Large, wart-like growths on their muzzles enhanced the already stunningly repulsive appearance of the *Tyrannosaurs.*

The plain on which the *Maiasaura* nests were made was located close to the western mountains. The plain descended to the north, and a few kilometers south of the international boundary, on the Blackfoot Reservation in Montana, another series of badlands has formed in its sediments. This site is very rich and will surely yield important information on dinosaurian ecology. Eggshells occur there in great abundance, as well as the bones of numerous other dinosaurs, but none has been identified as belonging to *Maiasaura*. Among the dinosaurs present were the hypsilophodont that nested near the *Maiasaura* site, as well as a new spiny-frilled, horned dinosaur and a small, hornless "horned" dinosaur, or protoceratopsid. None of these is known to occur in lower, more northerly regions of the plain. However, remains of the most of the other dinosaurs have also been identified in a great fossil field in Alberta.

Hadrosaur Giants

The magnificent escarpment of the Book Cliffs extends from western Colorado far into central Utah. Within it are preserved sediments that trace the

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movements of the interior sea, as its shoreline withdrew to the east across this region (Mesaverde Formation, 675 meters [2,200 feet] thick) about 75 million years ago. Swamps and floodplains pursued the retreating sea, but often foundered beneath it during brief readvances, when they were covered by marine clays. Dinosaurs walked across the soft peaty bogs near the shore, and their footprints were filled with silts and sands carried to them by flooding rivers. The peat subsequently changed to coal, and the sands and silts to stone. Throughout eastern Utah and western Colorado, sandstone footprint casts are preserved on the roofs of mine shafts, their contours projecting into the subterranean gloom after the coal is removed.

The footprint casts can be so dense that they merge into a trampled field. They were made by many different kinds of dinosaurs, nearly all of which were moving with their tails clear of the ground. Tail drag marks are extremely rare. A few tracks were left behind by tyrannosaurs and ceratopsians, but most were made by bipedal herbivores. Many of these bipeds were very small animals, but whether or not they were infant or immature hadrosaurs is not known. At one site hadrosaur footprints were found among fossilized leaf litter, fallen branches, and upright, coalified tree stumps. Some animals had actually stepped on the major roots, and their footprints are positioned around the stumps in a manner suggesting that the hadrosaurs were browsing within the lower branches of the tree. A few of the hadrosaur tracks were one meter wide, indicating animals that weighed about 12 metric tons.

Virtually all the hadrosaur skeletal materials found in North America were derived from animals weighing between 2 and 4 metric tons. A jaw-bone collected in Wyoming belonged to an animal that probably weighed on the order of 8 metric tons. But the arm bone from Baja California and a few footprints from Colorado and Utah are the only available evidence of truly giant hadrosaurs on this continent. The remains of giant hadrosaurs are relatively more common in late Cretaceous sediments in central Asia. In Mongolia, a tubeheaded hadrosaur (*Barsboldia*) and a flat-headed hadrosaur with a cranial spine (*Saurolophus*) both attained lengths of approximately 12 meters (39 feet) and weights of 10 metric tons. The largest known hadrosaur was the flat-headed *Shantungosaurus* from eastern China, a mounted skeleton of which is nearly 15 meters (49 feet) long. The animal weighed about 12.5 metric tons when alive.

In living animals many ecological and behavioral characteristics are closely correlated with adult weight. These relationships can be used to pose questions on how the natural histories of 2-metric-ton and 10-metric-ton hadrosaurs might have differed, and the inferences thereby gained can be kept in mind when reviewing the fossil record. For example, according to the relationships, the number of large hadrosaurs in a region would be less than half that of their smaller cousins, but the weight of all the large hadrosaurs combined would be nearly twice as much. The eggs of the large hadrosaurs would be three times heavier, the number laid would be only three-quarters that of the smaller hadrosaurs, and about half as many nests would occur in each rookery. If they migrated without feeding, large hadrosaurs would consume their total bodily fat reserves at about half the rate of small hadrosaurs. Small hadrosaurs could have easily migrated over distances of one to two thousand kilometers (620 to 1,250 miles); the large ones may have covered distances of continental proportions. If the large Asian hadrosaurs reached the Bering Straits during the arctic summer, might the few North American occurrences of the giants represent occasional visitors from the east? The correlates of body size provide invaluable tools with which to extend the reality of fossil bones and search for silhouettes of once-living creatures.

Dale A. Russell is one of the world's leading authorities on dinosaurs. A native of California, he has spent most of his professional career with Canada's National Museum of Natural Sciences. Following the trail of the dinosaurs he has traveled the world: North America, Africa, and Asia, most recently as part of a joint Chinese-Canadian expedition exploring northern China for remains of the giant reptiles.

Artist Eleanor Kish is internationally acclaimed for her portraits and scenic reconstructions, which have been commissioned by museums and galleries around the world. She is currently working on a mural for the Smithsonian Museum of Natural History.

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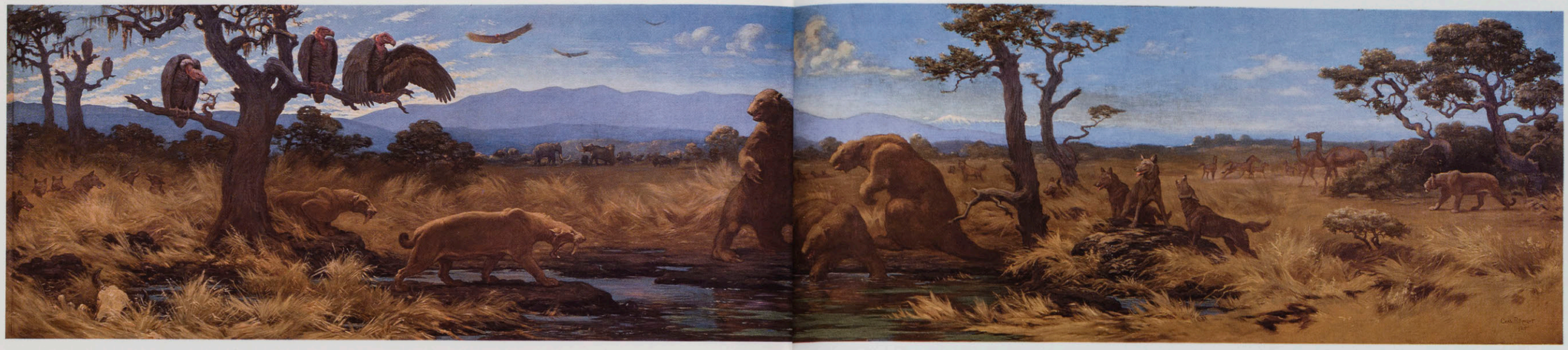
TRAPPED IN TIME
Restoration of Charles R. Knight Mural

by JOHN M. HARRIS



Charles Robert Knight (1874-1953) was the first artist to really bring prehistoric animals to life. The remarkable realism of Knight's work is due to a combination of his own innate artistic talent and his belief that animals must first be understood before they could be portrayed. Thus each of his renditions of long-extinct animals was based in part on his familiarity with the anatomy and behavior of living organisms and in part on extensive consultation with the leading paleontologists of his time. The result was a body of work—800 drawings, 150 oil paintings, and numerous sculptures— that provides the foundation for our modern concept of prehistoric life.

The Natural History Museum owns several works by Charles Knight, the most famous of which is the 50-foot-long mural depicting life at Rancho La Brea (the world-famous Los Angeles "tar pits") at the end of the last great Ice Age. The mural was commissioned in 1925 by William Alanson Bryan, then director of the museum, for the gallery that housed the fossils from the "tar pits." It was installed in 1926 and remained on display until August of this year. The cost of the original commission was $5,000. An appraisal of the mural earlier this year by Sotheby's of New York re-estimated its value at $500,000.

This spectacular rendition—showing ground sloths, saber-tooth cats, dire wolves, and scavenging birds grouped around an asphalt pool, and with lion, camels, horses, bison, and mammoths roaming before the backdrop provided by the Santa Monica Mountains—is one of Knight's greatest and most famous creations. Moreover, it places the "treasures of the tar pits"—the countless number of fossil bones, shells, insect and plant remains retrieved from asphalt excavations in Hancock Park—in a readily understandable context and helps us visualize what life was like in the Los Angeles Basin between 5,000 and 40,000 years ago. Knight's restoration of the saber-tooth cat (*Smilodon californicus*, the state fossil of California), which is the focal point of the entire mural, provided the basis for the museum's now well-known logo.

Unfortunately, the future of this magnificent work is far from assured. It was never varnished or lined after completion and has now begun to deteriorate. Restoration will be costly. The museum's Earth Sciences Division and Registrar's Office were successful in obtaining a matching grant for $25,000 from the Institute of Museum Studies toward the cost of the necessary restoration, the total cost of which will be about $70,000. The Natural History Museum Foundation is now seeking support for the balance needed to ensure that Knight's mural is preserved for the appreciation of future generations.

Knight's mural was permanently installed more than sixty years ago, but on a temporary stretcher and in a gallery that lacked climate control. The vicissitudes of the southern Californian environment—seasonal climatic changes with lots of sun and the occasional earthquake to rattle things around—eventually resulted in the onset of deterioration in Knight's masterpiece. Earthquake-induced vibration wore holes at the edges of the canvas where the mural was fastened to the wall and, in one of the two panels, this plus the weight of 500 square feet of oil-impregnated canvas caused the painting to start separating from its stretcher. Emergency repair work was undertaken at the end of July by Rosamund Westmoreland, formerly Head Conservator at the National Portrait Gallery of the Smithsonian Institution, and the painting is now being stored until funds can be raised to complete its restoration.

In light of the results of research undertaken on Rancho La Brea fossils during the past two decades, the purist may quibble with certain details of the Knight mural. The vulture-like creatures, perching on the cypress tree while awaiting the outcome of the confrontation between the saber-tooth cat and ground sloths, depict Knight's interpretation of Merriam's teratorn (*Teratornis merriami*), the largest fossil bird from the Rancho La Brea deposits. Recent studies of teratorns by Dr. Ken Campbell, the museum's curator of Fossil Birds, has indicated that this bird, which weighed about 30 pounds and had a wingspan of about 14 feet, was not a vulture-like scavenger, but stalked its prey from the ground. Research on some of the other fossil animals depicted by Knight has suggested other minor anatomical changes might be appropriate.

In addition, we now believe that the vegetation present in the Los Angeles Basin at the end of the last Ice Age was rather different from that portrayed by Knight. George Jefferson (Head of the Rancho La Brea Section) and his co-workers have undertaken studies of the food particles preserved in the teeth of some of the larger fossil herbivores. Whereas today, as in the past, horses and bison feed mainly on grasses, the teeth of these animals from the asphaltic deposits are packed with twigs and leaves from shrubs and herbs with only a small percentage of grass. This suggests that there was probably less grass present in the local habitats than was depicted in Knight's restoration.

Local artist Mark Hallett recently undertook a revision of the Rancho La Brea mural that incorporated these and other changes as part of the "Treasures of the Tar Pits" traveling exhibition (see *Terra* November/December 1988). Hallett's other restorations of dinosaurs and prehistoric mammals have won international acclaim. While destined to become equally as famous as an accurate record of life present at Rancho La Brea during the Late Pleistocene, the Hallett mural is on a much smaller scale and lacks the sweeping grandeur of the Knight rendition.

Stephen Jay Gould, the noted paleontologist from Harvard University, considers Knight to have been as important a figure in the history of paleontology as any of the major scholars of his period—"for the man who established images for the entire world has set the thoughts and concepts of a generation." Gould writes that it would be simply unthinkable to let the Rancho La Brea mural deteriorate further—"this would be tantamount to destroying the last surviving copy of Darwin's *Origin of Species* and then letting scholars work only from facsimiles."

The necessary restoration work will include careful but thorough cleaning of the canvas, patching the holes, lining the painting, varnishing it to conserve the canvas and restore the original dramatic color, and rehanging it on appropriate permanent stretchers. Another $40,000 is needed to underwrite this task, which will take a team of skilled conservators between four to six months to complete. Please contact the Natural History Museum's Development Office, 900 Exposition Boulevard, Los Angeles, CA 90007, if you are able to help support this project.

Humpback cow and offspring in the winter calving grounds off the Hawaiian Islands. The calf will stay with the mother for about ten months to a year.

LEVIATHAN AMOUR

The Mating Systems of Whales and Dolphins

by JOHN E. HEYNING

When we think of *cetaceans* (whales, dolphins, and porpoises), we typically conjure up spectacular images of whales leaping from the water or the graceful ballet of dolphins as they bowride a boat. Although these behaviors are most familiar to us, cetaceans also have complex social behaviors related to breeding. In spite of a tremendous increase in our knowledge regarding many aspects of their biology, we still know very little about the social and mating sytems of these animals. This is partly because most of their activities including courtship and mating occur beneath the ocean's surface, far from the watchful eyes of biologists. Even the scientific literature is filled with misconceptions regarding this most basic of biological topics, such as the idea that mating humpback whales leap from the water in unison and that voyeuristic male gray whales will assist in keeping an amorous pair of whales together during mating.

Now, however, supplied with a range of long-term observations on such species as humpback, killer, sperm, and right whales and using high technology such as DNA fingerprinting, biologists are beginning to unravel these secrets of the deep. This diversity of mating systems is found in both major groups of cetaceans: the numerous species of toothed whales, which include the dolphins and porpoises, and the larger filter-feeding baleen whales.

Mating Systems

Reproductive success is imperative for all species. As a species evolves, those individuals that produce the most viable offspring are typically the most successful. Progeny that survive to reproduce ensure that their parents' genes have the best chance of being perpetuated into future generations. Animals have evolved ingenious strategies to meet this goal, and we are just beginning to understand this diversity of *mating systems* and the underlying factors that have allowed them to evolve. Cetaceans demonstrate several of these strategies as well as the social mechanisms that prevent inbreeding.

There are three basic mating systems in the animal kingdom: *monogamy* (one mate), *polygyny* (many females), and *polyandry* (many males). As with most characteristics in nature, these mating systems represent the extremes along a continuum. Although many species can be categorized as one type, individual animals may demonstrate components of another mating system. For instance, elephant seals are among the best examples of a polygynous species, yet bulls not holding territories may successfully mate with females at the perimeter of the harem.

The monogamous system is one in which individuals in a species will mate with only one partner during each breeding season. For some species, the pair will form a bond that lasts for a breeding season or for life, often with the male contributing to the rearing of the young. Several species of foxes and birds are examples of animals that use this strategy.

Polygyny is another common mating system among mammals. In a polygynous system, one male will mate successfully with several females. In many polygynous species, males will fight other males to secure exclusive breeding access to several females, which are often referred to as a harem. Typically in this mating system, the males are different in size and appearance from the females, a feature known to biologists as *sexual dimorphism* (i.e. two forms). For example, only male deer have antlers (except reindeer) and they use them, at least in part, to fight other males during the breeding season. Extremes in polygyny and sexual dimorphism can be found among such marine mammals as the southern elephant seal in which the males are ten times the size of females and one dominant bull may have breeding control over many tens of females. Although monogamy is considered the ideal in our society, a study of over 800 human societies has shown that 83 percent demonstrate some degree of polygyny.

The opposite of polygyny, polyandry is extremely rare among higher vertebrates. This is probably because the females of birds and mammals are limited to the number of offspring they can produce at a given time, whereas males theoretically have almost no limits as to the number of offspring they can sire. Nonetheless, some exceptions include a few species of North American birds such as the Northern Jacana and phalaropes. Mammals are probably further hindered from evolving polyandry by the constraint that females alone provide the nutrition for the young by nursing, whereas both the male and female of most species of birds can contribute equally to the nutritional needs of their offspring.

The above categories can also be defined by the ratio of individuals of either sex that contribute gametes (either sperm or eggs) to the next generation. When an equal number of males and

females contribute gametes to the next generation, we term this monogamy. If a lesser number of males contribute gametes than females it is polygyny, and if more males contribute gametes than females we define this as polyandry. Superimposed on these categories based on genetic contributions are some behavioral classifications. For instance, males and females may only interact during the actual mating, short-term pair bonds may form, or long-term pair bonds may form.

Social Organization

The social organization of a species may not be useful in predicting which particular mating system is used. However, there is tremendous variation among species in the level of social bonding between males and females, and between calves and mothers. As a rule, baleen whales lack the long-term complex social organization that many species of toothed whales exhibit. Short-term associations tend to be the rule and the calves are typically weaned from about seven months to one year in age. In many groups of toothed whales, such as sperm whales and many species of oceanic dolphins, large numbers of animals associate together in cohesive groups known as *schools* or *pods* that are often further subdivided into more tightly organized subgroups within each pod. The calves nurse longer than baleen whales with weaning occurring from one to three years in most species of toothed whales. In some of the most socially complex species such as sperm whales and pilot whales, there is evidence that some calves may be suckling up to ten years or more. This suckling is not essential nutritionally, as these juveniles are primarily feeding on solid food. This phenomenon is not yet understood, but may represent a long-term bonding mechanism so that the young can learn the complex social organization and hierarchy of the pod.

Because observations of actual matings are so rare, we know little about which cetacean species are truly monogamous. It does appear that males of most species contribute little, or nothing, to the rearing of calves. It is assumed that some species of baleen whales, including the blue whale, are probably monogamous or only slightly polygynous. Most river dolphins, porpoises, and some oceanic dolphins also appear to be monogamous or slightly polygynous.

Several species are known or suspected to be polygynous. This occurs in subtle forms such as in bottlenose dolphins, the species most often seen in oceanaria and on television. Based on observations of captive bottlenose dolphins, we know that some males are dominant within a group and may prevent subordinate males from mating, yet this species is not particularly sexually dimorphic. Males attain a slightly larger adult size than females. Long-term studies of free-ranging bottlenose dolphins off Florida have shown that the basic core of social organization is groups of closely related females and their offspring. Subadults of both sexes will often leave this group, but the females usually return to their mother's group when they bear their first calf. The males will form small groups and venture farther than the limited home range of the female groups. Adult males will join up with various female groups for short periods of time, presumable for mating. Researchers studying the social organization of bottlenose dolphins suggest that the mating system lies somewhere between the polygynous and monogamous strategies.

Recent work on pilot whales around the Faroe Islands in the North Atlantic have shown these toothed whales have a polygynous mating system. A recently developed technique called *DNA fingerprinting* has allowed a glimpse into the social organization of pilot whales. DNA fingerprinting reveals that each individual has a unique pattern of bands when the DNA is extracted, radioactively marked, and blotted onto a special gel. By examining the patterns of bands of the offspring and subtracting the bands contributed by the mother, the identity of the father can be deduced. This technique is used on humans in paternity and criminal cases.

In the Faroe Islands, whole schools of pilot whales have been driven ashore and used for local consumption for hundreds of years. Recently researchers have examined tissue samples from these groups of pilot whales and determined that the father of small fetuses could be found within the school, or pod, but no father of older fetuses could be found in the school. This has been interpreted to mean that breeding males will wander from school to school, remaining with any particular school for at least several weeks to a couple of months. The fathers of older fetuses had already left the school. Pilot whales exhibit a moderate degree of sexual dimorphism: males grow larger and develop a more bulbous head.

One well-studied species is the sperm whale, the largest of the toothed whales. Female sperm

Long-term observations of killer whales have been documented in the Pacific Northwest for almost two decades. Behavioral observations of the social interactions are aided by the fact that killer whales are sexually dimorphic; males are bigger and have a larger and more triangular dorsal fin.

J. HEYNING

whales attain a maximum adult length of 40 feet (12 m). The males may grow to 60 feet (18 m) and weigh up to three times as much as females. Females and young travel in stable cohesive groups termed *nursery schools* and remain primarily in tropical and temperate waters. Adult males, or bulls as they are known, travel either singularly or in pairs. These breeding bulls will venture into high latitudes for much of the year and wander into warmer waters to breed with females. When a bull enters a nursery school, it then becomes known as a harem. It was previously romanticized that the male would stay with his harem gallantly fighting off intruding males for at least one breeding season. While extensive scars and field observations of adult male sperm whales indicate that they will fight for breeding access to females, recent studies off the Galapagos Islands have shown that the average stay of a bull in a nursery school is about six hours, even far less than the time spent by male pilot whales with female groups. It seems that breeding males roam from nursery school to nursery school seeking females that are currently in estrus and thus receptive for breeding. This strategy has previously been documented in male African elephants.

Genetic Diversity

Mechanisms that prevent inbreeding have an important effect on the social organization of animals. Inbreeding limits the genetic variation of offspring and may allow detrimental genes to become dominant. Genetic variation also ensures that at least some individuals are more likely to resist new diseases or changes in the environment. In several relatively well-known species such as bottlenose dolphins, pilot whales, and sperm whales, males leave a matriarchical school or pod about the time they approach sexual maturity. In sperm whales, at least, these males form bachelor pods that decrease in size as the animals mature. Finally, at about twenty-five years of age, the physically and socially mature bulls typically travel singularly or in pairs. These socially mature males travel from pod to pod mating with receptive females. This contributes significantly to the pod's genetic diversity.

This is a nursery school of sperm whales off the Azores. Nursery schools are comprised of adult females and their calves. Mature males travel either alone or in pairs and join these nursery schools for only a few hours for breeding.

T. ARNBOM, INTERNATIONAL FUND FOR ANIMAL WELFARE

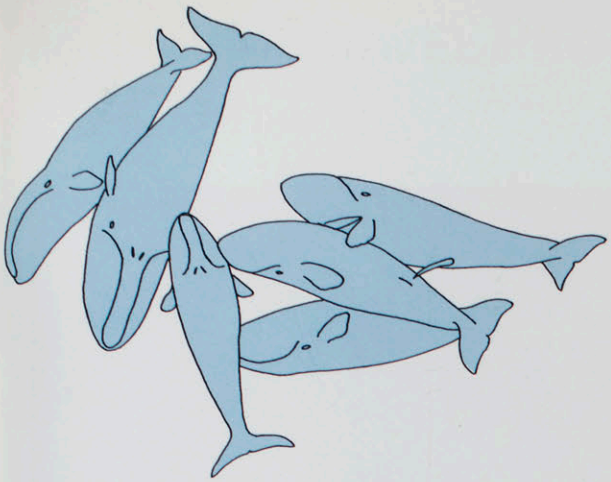
An aerial view of a mating assemblage of bowhead whales in the Arctic. At least six animals can be seen in this photograph (see accompanying figure).

NATIONAL MARINE MAMMAL LABORATORY

In killer whales, the female offspring tend to stay in the same pod as their mothers, a common social organization among several groups of toothed whales. However, male killer whales differ from the other toothed whales discussed earlier in that they also tend to stay with their mother's pod into adulthood. This would seem a paradox to the rules of inbreeding because the whole pod consists of closely related animals. Based on observations in the Pacific Northwest, several pods will temporarily join into larger social groups termed "superpods." During these multipod associations, mating behavior is seen at a higher frequency than at other periods, which suggests that breeding between members of different pods may be occurring. Other recent observations indicate that some male killer whales may travel with other pods for short durations, apparently for breeding purposes.

Male-Male Competition

Humpback whales are baleen whales that mate and calve in tropical waters off such island archipelagoes as Hawaii and the Caribbean islands. Observational data collected over the last decade indicate that a male, termed an *escort*, will accompany a female, often one that has recently given birth, and is presumably receptive for mating. The escort male will fight rather vigorously with other males that attempt to move close to the female. Thrashing the tail side to side or slapping it against the surface of the water (lob tailing) are known aggressive behaviors. Vocal threats have been documented among male humpback whales during competition for females. Male humpback whales will also ram other animals with their heads, and with the barnacle growths on their heads, cut the skin of rival males.



Although only slightly sexually dimorphic in shape to our eye, male humpback whales perform haunting and melodious songs. These songs are performed only in their entirety on the breeding grounds. This song may be a territorial display to other males, a luring song for females, or some combination of both. One recent theory suggests that the length of time a male can sing prior to surfacing for air conveys some information as to the physical condition of the male. Singing humpback whales often assume a head-down posture beneath the surface and perhaps this posture adds visual significance to the song.

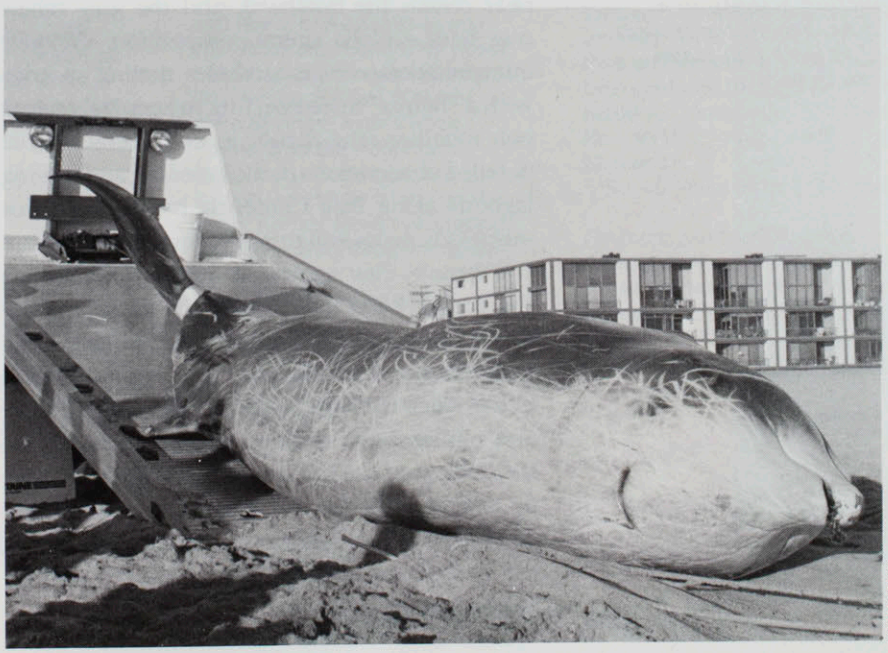
Beaked whales are a poorly known group of toothed whales with species ranging from 12 to 40 feet (3.7 to 12 meters) in length. Most species are quite sexually dimorphic and presumably polygynous. The teeth of females in most species of beaked whales never erupt from the gums, and their bodies relatively free of scars. The males, however, have one pair of enlarged teeth that erupt around the time of puberty, and they use these teeth to fight other males of the same species. These fights result in tremendously scarred bodies. The skull in the snout of adult males of many species is reinforced with dense bone to reduce the chance of breakage when the males use their teeth to fight. We assume these fights are related to breeding hierarchies among males. Almost all the scars present on older males are healed, providing evidence that most battles are not fatal.

The narwhal, or unicorn whale, is another example of a species with sexually dimorphic teeth. In this Arctic species, the upper left tooth of males erupts from the gums about the time of sexual maturity and develops as a long spiraling tusk. This tooth is used by the males for visual threats and fights with other males. Field observations suggest that males use their tusks primarily in display or in a type of sparring similar to our sport of fencing. Rarely do these whale stab each other, and fights to the death seem to be uncommon.

Sperm Competition

We have seen how physical competition based on aggressive interactions may be used by one male to prevent other males from mating with a female. In the past decade or two, a quite different level of competition between males has been discovered. Instead of several males competing physically to exclude other males from mating, more than one male will mate with a female and the competition to fertilize the egg occurs at the level of the sperm. This idea of *sperm competition* was first documented in some insects, but has subsequently been found in several species of birds and mammals. In those species that engage in sperm competition, the goal is to deliver the sperm as close to the egg as possible and produce such copious amounts of sperm that it will displace the sperm of rival males. Thus, these species have relatively large penises to deposit the sperm close to the egg and enormous testes to produce a tremendous volume of sperm.

Therefore, to suggest that sperm competition occurs within a species, the following criteria should be evident. Males should have testes far larger than predicted for body size and many males should be observed mating with a receptive female with little aggressive interaction among the competing males. Sperm competition was first suspected in some whales when biologists began comparing the testes size in different species. The extreme are right whales, a baleen whale species with an average adult length of 45



DON MEYER

A dead stranded adult male Cuvier's beaked whale. Eruption of one pair of teeth from the gums occurs only in mature males; the males use these teeth only for fighting other males of the species as evidenced by the numerous linear scars. All the scars on this animal were healed, testaments to previous aggressive interactions.

S. SWARTZ

The gray whale, which migrates along the Pacific Coast of North America during the winter and spring months, is one species now believed to exhibit sperm competition. In this photo several animals are engaged in mating activity in a Baja lagoon; the penises of at least two males can be seen.

to 60 feet (14 to 18 meters) for which the combined testes may weigh one ton (970 kilograms). In contrast, a much larger 90-foot (27 meter) blue whale has an average combined testes weight of only 150 pounds (70 kilograms). Based on behavioral and anatomical evidence, it is now believed that among the baleen whales the right whale, its near cousin the bowhead, and the gray whale may have evolved sperm competition. Previous interpretations of gray whales mating in trios with a "helper" male assisting to keep the mating pair together now appear to be incorrect. More detailed observations in the breeding and calving lagoons along Baja California have shown that numerous males will pursue a presumably receptive female. Few aggressive interactions among the males have been noted in these mating assemblages. Similar observations have been documented for bowhead and right whales. Other baleen whales, such as the blue, finback, and minke, seem to be monogamous based on field observations indicating there are no groups of mating animals, nor aggressive interactions among males, and these species have testes that are average or slightly smaller than predicted for the size of the animals.

None of the mating systems mentioned above are unique to whales and dolphins. Yet it has been only quite recently that biologists have begun to elucidate the reproductive patterns utilized by cetaceans. Further anatomical and behavioral studies coupled with genetic analysis should yield a wealth of information in the near future. A new procedure, called biopsy darting, seems particularly important. This technique employs a dart that is fired by crossbow at the whale. The specially designed tip of the dart removes a small plug of skin and blubber, which is retrieved by means of a float or line. This tissue plug contains DNA that can be used for either fingerprinting studies or population genetics. This procedure allows for the genetic analysis of free swimming cetaceans and can be compared with behavioral observations. This essentially benign technique should provide the lens by which we can truly peek into the social organization of these elusive leviathans.

Dr. John E. Heyning is an Assistant Curator of Mammals at the Natural History Museum. His research interests include the anatomy, evolution, and natural history of cetaceans. Dr. Heyning is responsible for coordinating the museum's Marine Mammal Stranding Program.

MUSEUM TRAVEL PROGRAM

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Jungle Rivers of South America

April 10–25, 1990

Explore the Orinoco River and Angel Falls in Venezuela, cruise the South American coast to Devil's Island, French Guiana, and journey 1,200 miles up the Amazon through Brazil's rapidly disappearing rainforest aboard the *Society Explorer* with museum entomologist Dr. Charles Hogue. **Expedition Night! Please join the Museum Travel Program on Thursday, January 18, at 7:00 P.M. in the Museum's Times Mirror Room for a slide lecture on the Amazon.**

From $4,940 plus airfare

Tunisia

April 15–May 9, 1990

Wander through 3,000 years of Tunisian civilization: Punic, Roman, Arab, Berber, Moorish, Turkish and French, introduced in the exhibition now on display at the museum **Carthage: A Mosaic of Ancient Tunisia.** Visit troglodyte villages, Roman ruins, sacred mosques, and learn about Tunisian folklore as you meet artisans and share meals in Tunisian homes on this comprehensive exploration of Tunisia.

$3,990 plus airfare ($1,214)

Nomads of Central Asia

April 28–May 17, 1990

View the peoples and cultures introduced by the museum's recent exhibit, **Nomads: Masters of the Eurasian Steppe,** as you visit the historic towns of Alma-Ata, Chimkent, Tashkent, Samarkand, and Bukhara, as well as the treasures of Leningrad and Moscow.

$4,262 plus airfare ($788)

Egypt: the Magnificent Nile

May 19–June 3, 1990

Steal away to the mystery and romance of the Nile aboard the luxury yacht **Nile Empress.** Follow the path of the pharaohs to the pyramids, Sphinx, Abu Simbel, Luxor, Karnak, Valley of the Kings – an endless list of splendors to explore with noted Egyptologist Dr. Nabil Swelim.

$4,172 including airfare

East Africa Wildlife Safari

June 21–July 7, 1990

Trek through the major reserves of Kenya; Samburu, Masai Mara, and Amboseli, and the best parks in Tanzania; Ngorongoro Crater, Serengeti, and Lake Manyara, on this wildlife safari led by museum naturalists.

$5,195 including airfare

Australia – Nature's Best-Kept Secret

July 21–August 11, 1990

See the diverse and unique flora and fauna of Australia as you visit Brisbane, Lone Pine Koala Sanctuary, Lamington Plateau, Darwin, Fogg Dam, Kakadu, Alice Springs, Ayer's Rock, Cairns, and the Atherton Tablelands. Conclude your journey on Heron Island on the Great Barrier Reef, celebrating next summer's museum exhibit on sharks.

$4,998 including airfare

Santa Fe Indian Market and Pueblo Indian Feast Days

August 10–20, 1990

Stay in Albuquerque, Taos, and Santa Fe while visiting a wealth of museums, archaeological sites, national monuments, pueblos, and galleries with anthropologist Kendra Bowers. Visit the world-famous Sante Fe Indian Market, where hundreds of artisans display and sell their wares.

TBA

Peru

October 16–November 4, 1990

Journey to the Valley of Lambayeque to visit the treasures of Lord Sipan's royal mausoleum. Also featured are the Andean Inca fortresses of Machu Picchu and Sacsayhuaman, the colorful Indian markets of Chincero and Pisac, and Colca Canyon in the Arequipa region, with a chance to see the legendary Andean condors.

$3,195 including airfare

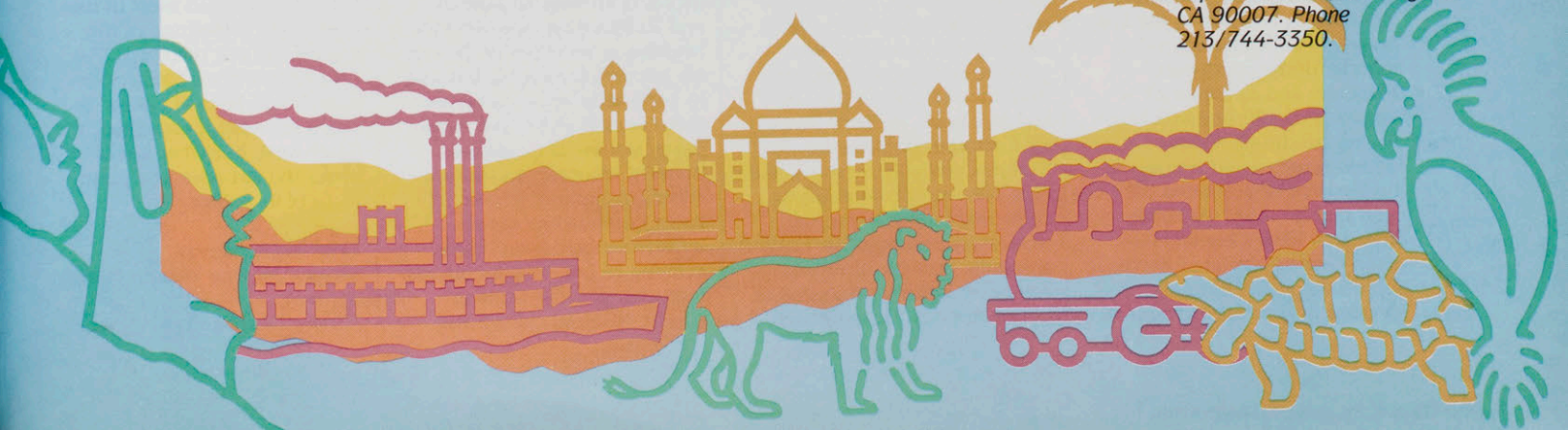
Singapore and Thailand

November 3–19, 1990

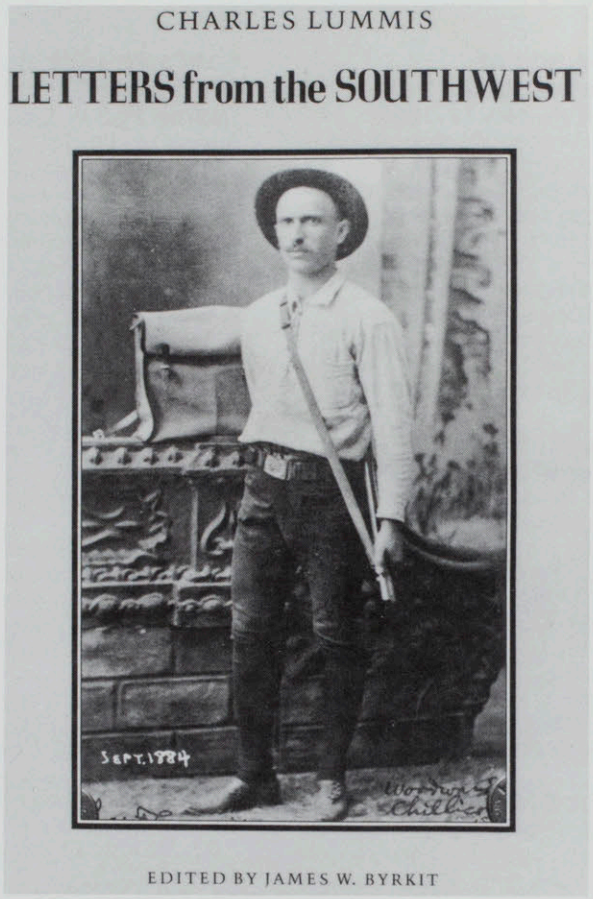
Enjoy glimpses of Singapore's many cultures, then travel on to Bangkok, "Venice of the East," for an overview of past and present Thailand. Visit the colorful native market of Phitsanhothai, then travel on to Chaing Mai, "Flower of the North," typified by impressive mountain scenery, ancient temples, colorful tribes, and an amazing array of handicrafts. Visit an elephant training camp, then continue through beautiful mountain landscapes to Chaing Rai, northernmost province of Thailand.

$2,450 plus airfare ($1,258)

For more information, please contact Karen Hovanitz, Museum Travel Program Coordinator, 900 Exposition Blvd., Los Angeles, CA 90007. Phone 213/744-3350.



BOOK REVIEWS



LETTERS FROM THE SOUTHWEST, SEPTEMBER 20, 1884, TO MARCH 14, 1885, by Charles Lummis and edited by James W. Byrkit.
University of Arizona Press, 1989, $29.95.

SOME STRANGE CORNERS OF OUR COUNTRY, by Charles F. Lummis with a foreword by Lawrence Clark Powell.
University of Arizona Press, 1989, $12.95 (paper).

Charles Fletcher Lummis (1859-1928) was a tireless promoter of Los Angeles and the Southwest. During his lifetime he filled this role in various ways: as city editor of the *Los Angeles Times;* as editor of the monthly magazine *The Land of Sunshine;* as librarian of the Los Angeles Public Library; as a founder of the Southwest Museum; and as author of numerous books and articles on the region. In all of these efforts he promoted himself as tirelessly as he promoted the land that he made his home. When, in 1884, General Harrison Gray Otis offered him a job on the *Times,* Lummis decided to turn his arrival in Los Angeles into a major publicity stunt. Rather than take the train from Chillicothe, Ohio, he decided to walk the 3,507 miles instead. (He wore a pedometer.) The young journalist recorded his adventures along the way in a series of letters that he sent ahead to be published in the *Times* so that readers could follow the progress of his journey.

James W. Byrkit, on the faculty of Northern Arizona University, has discovered that Lummis not only published an account of his trek in the *Times,* but also in the Chillicothe *Leader,* where he had worked before leaving for California. Byrkit has gathered these letters together for the first time and published them in *Letters from the Southwest, September 20, 1884, to March 14, 1885.* Byrkit regards the *Leader* letters as more spontaneous and less given to self-aggrandizement than the accounts in the *Times* and in a book, *A Tramp Across the Continent,* published in 1892. Byrkit is probably correct about this, but one should not conclude that Lummis was ever a modest man even in the *Leader* accounts. Lummis always comes off looking very good in his adventures. He easily dispatches a couple of tramps who accost him on a lonely stretch of railroad track; he shows kindness to fellow travelers; he weeps when his faithful dog Shadow goes mad in the desert and he is forced to shoot him. (In the latter incident, he emphasizes the remarkable accuracy of his marksmanship.)

Although Lummis wrote clearly and vividly, Byrkit admits that the young journalist was no literary giant. A reading of his *Letters* will confirm that fact. Lummis has many interesting things to say about what he saw along the way, but the letters are more valuable for what they reveal about their author than about the American West in 1884. An example is Lummis's attitude toward the wildlife that he encountered along the way. His appreciation of Western fauna seems fulfilled only when he has killed what he sees. At one point, he lamented the disappearance of the great buffalo herds that once darkened the prairies. A short time later, he shot two antelope and left their carcasses to rot on the plains. He occasionally carved a steak out of one of his victims or skinned it to sell the hide, but food or profit is not the real reason for his slaughter. To Lummis, and others of his generation, shooting seemed to be the natural response when encountering any form of wildlife.

In southern Colorado, Lummis stepped over what he called "the line from an alleged American civilization into the boundaries of one strangely diverse." (p. 96) Although he was to later become a champion of this Southwestern civilization, his first reaction was not unusual for a New England, Harvard-educated white male of the late nineteenth century. He adopted the word "Greaser" for Mexican without hesitation and accepted on face value the negative stereotypes of the era. He admires the Pueblo Indians, in part, because he perceives them as embodying the Anglo Saxon virtues of cleanliness, honesty, courtesy, and so on. Although quite provincial initially, Lummis was not an inflexible racist. Even before arriving in Los Angeles his attitude changed. He came to admire Mexican culture and civilization–even acquiring a taste for spicy food. (In an 1895 editorial in *The Land of Sunshine* a more mature Lummis condemned the use of the word "Greaser" as a mark of poor breeding.)

Byrkit has done a fine job of editing *Letters from the Southwest.* He allows the letters to speak for themselves with minimal editorial comment. Although the professor occasionally pushes his admiration of Lummis to the point of hero-worship, he supplies an interesting introduction about a fascinating personality.

Some Strange Corners of Our Country is a much less satisfying book. It is a reissue of a volume originally published in 1892. The University of Arizona Press has put out this new edition without change other than a short foreword by Lawrence Clark Powell. Lummis himself expanded and reworked the volume and published it in 1925 under the title, *Mesa, Canyon and Pueblo. Some Strange Corners* is an example of late-nineteenth century regional promotional literature. It is a catalogue of the exotic, bizarre and otherwise strange things to be seen in America's Southwest. We can learn that the dances and religious rites of the Southwest's Native American populations are as exotic as those of Africans. We learn that the mountain and deserts are as breathtaking and forbidding as any found elsewhere in the world. We learn that the region's ancient ruins are as remarkable as those of Egypt. Lummis, in his final paragraph, sums up the purpose of the book very well. "The whole West is full of wonders, and we need not run to other lands to gratify our longing for the curious and the wonderful. The trip abroad may at least be postponed until we are ready to tell those we shall meet in foreign lands something of the wonders of our own." (p. 270) Like *Letters, Some Strange Corners* should be read not so much for what it says about the Southwest, but what it tells us about the attitudes and prejudices of its author.

Errol Wayne Stevens
Seaver Center for Western History Research
History Division

MEMBER'S TICKETING INFORMATION

Exhibition Dates: December 16, 1989 - March 18, 1990.

Museum Hours: Tuesday through Sunday, 10 a.m. to 5 p.m.
Closed Mondays except December 18, January 15, and February 19.

Reservation Times: Entrance to the exhibition is on the half hour.
Last ticket choice is 4 p.m.

Ticket Prices:

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Children (5–12)	$1.00

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DINOSAURS! is funded locally by Occidental Petroleum Corporation, with additional support from Kajima International and Jack in the Box.

Focus on the West

This photograph shows Avalon harbor around 1940, as seen from the terrace of Mount Ada, home of William Wrigley, Jr. The steamships *Avalon* and *Catalina*, shown anchored at the pier, brought passengers to this popular tourist mecca. The casino building in the distance had a movie theater downstairs, and the big bands of the era performed in the dance hall on the main floor.

This picture is from the collection of *Pictorial California*, perhaps the leading magazine of its day visually promoting life in California "and the Pacific," as it was later subtitled. First appearing in December 1925, *Pictorial California* was filled with pictures of such scenic wonders as Yosemite, glamorous vacation resorts and hotels, and visits with movie stars at home and on the set. Orange groves in front of snowy mountains and bathers sunning at the beach in January were typical examples of this enthusiastic boosterism.

When *Pictorial California* ceased publication in 1970, the magazine's photographic archives were acquired by the Natural History Museum, and they are now housed in the Seaver Center.

GENERAL PHOTO FILE 8366

Focus on the West: Images from the Seaver Center *is a* TERRA *feature that presents the photographic highlights of the museum's Seaver Center for Western History Research. The Seaver Center is rich in photographs and other materials relating to the history of the American West.*

Housecalls

SEAVER CENTER FOR WESTERN HISTORY RESEARCH

Mapa de los Estados Unidos de Méjico (New York: J. Disturnell, 1847).

Where is California?

The problem, of course, is that there are several Californias, and there is just as much confusion about this in Mexico as there is in the United States. For much of the Spanish regime, a long slice of coastal land–some 1,500 miles–was known as California. In the 1700s, the region was divided in two, with the dividing line a few miles south of Rosarito Beach. The southern portion became Baja (Lower) California, while the northern portion became Alta (Upper) California.

For much of this early period, the capital was at Loreto, and both Californias were served by a single governor. This changed in 1804-05, when the governor of the Californias, Joaquin de Arillaga, actually became governor of Alta California, with his capital at Monterey, and Felipe de Goycochea became governor of Baja California.

When the United States obtained possession of Alta California in the 1840s, the word *Alta* was placed aside; therefore, there was a California (that of the United States), and a Baja California (that of Mexico). In Mexico, the peninsula in 1888 was divided in two at parallel 28°, and the bottom portion became known as Territorio Sur, with its capital at La Paz, and the upper portion took the name of Territorio Norte, with its capital at Ensenada (shifted to Mexicali in 1915).

Some twentieth-century changes have further complicated the ways in which the word "California" is used. Agricultural, manufacturing, fishing, mining, and political developments led to a substantial population increase in Territorio Norte, and in 1952 that portion of the peninsula became the state of Baja California; the lower portion retained its previous name, Baja California, Territorio Sur. Finally, in 1974, the southern portion was also granted Mexican statehood, and that region is officially known as Baja California Sur.

The above encapsulation of three hundred years of history we have pried from Curator of History William Mason. He reminds us that today there are three official "Californias": the State of California in the United States, and the two Mexican states, Baja California, and Baja California Sur. During the past ten years Mr. Mason has been involved in assembling a major collection of Baja California material, for which a computerized data base has been developed. Like all museum collections, these Baja California historical data are available for public use.

The museum's curators are often asked historical questions, or to identify artifacts and specimens that people have found, purchased, or inherited and animals, plants, minerals, and fossils that they have encountered in their yards or at the beach or on a hike. "Housecalls" is a feature of TERRA ***in which the museum's curatorial staff will discuss interesting questions that the museum's members and the general public have frequently asked them.***

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